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MICHIGAN STATE COLLEGE
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EAST LANSING

THE QUARTERLY BULLETIN

The Quarterly Bulletin of the Michigan Agricultural Experiment Station is issued in February, May, August and November. It presents progress reports on long-term major research projects and final reports on short-term projects.

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THE QUARTERLY BULLETIN

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MICHIGAN STATE COLLEGE
AGRICULTURAL EXPERIMENT STATION
EAST LANSING

C. M. HARDIN, DIRECTOR
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FEEDING OF ARSANILIC ACID TO PULLETS[1]

By DAVID A. LIBBY,[2] A. C. GROSCHKE,[3] ROBERT JOHN EVANS[4] and SELMA L. BANDEMER[5]

DEPARTMENTS OF POULTRY HUSBANDRY AND AGRICULTURAL CHEMISTRY

IT HAS BEEN KNOWN for a number of years that many organic arsenicals possess therapeutic values, particularly against parasitic invasions. For example, 3-nitro 4-hydroxy phenylarsonic acid is used as a coccidiostatic agent (Morehouse and Mayfield, 1946). Recently however, this compound has been shown to have marked growth-stimulating properties for poultry and swine (Bird, Groschke and Rubin, 1948; Morehouse, 1949; Carpenter, 1951). These growth-stimulating effects are in addition to those obtained by feeding antibiotics to young growing animals.

More recently another arsenical, arsanilic acid, has also been reported as stimulating growth of poultry (Bird, 1952). This compound is stated to have an advantage over other arsenicals in that it is less toxic to animals. But arsenic compounds when fed in small, nonlethal amounts are known to accumulate in the liver, fat and bone marrow. The question arises then whether serious consequences to human health could result from consumption of the flesh of animals which have been fed these compounds. As the matter now stands, the use of arsenicals as a growth promotant in feeds must be viewed with extreme caution until more information is gathered concerning arsenic in the physiology of farm animals. This project was therefore designed to obtain quantitative data on the deposition of arsenic in eggs and tissues of pullets fed graded levels of arsanilic acid.

PROCEDURE

Three lots of 20 Rhode Island Red pullets and 1 Rhode Island Red male each were housed in pens containing wheat straw litter and were

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fed an all-mash feed, water, and oyster shells *ad libitum*. The composition of the laying and breeder basal ration is given in Table 1. Egg production records were kept, and the eggs were gathered daily and incubated at weekly intervals.

The experiment covered a 17-week period from February to July 1952. For the first 3 weeks all three groups received the basal all-mash ration in order to reveal the normal picture with respect to body weight, egg production, hatchability, rate of chick growth and arsenic content of the eggs. During the following 11-week period, group 1 was retained on the basal ration, but groups 2 and 3 received in addition 90 grams and 180 grams of arsanilic acid per ton of feed, respectively. This was followed by a 3-week depletion period to determine the rate of disappearance of arsenic from the eggs and tissues.

To determine whether arsanilic acid in the maternal diet affects the early growth of chicks, the chicks from certain hatches (Table 5) were fed a complete practical-type broiler mash containing no antibiotics. The composition of the broiler mash is presented in Table 2.

TABLE 1—All-mash breeder ration

Ingredient	Composition
	Pounds
Ground yellow corn	60.65
Ground oats	10.00
Dehydrated alfalfa meal	5.00
Soybean oil meal	15.00
Fish meal	2.50
Steamed bonemeal	4.00
Oystershell flour	2.00
Salt (iodized)	0.50
Fish oil (600D, 2250A)	0.25
Vitamin mixture 2-49C	0.10
Other ingredients: Vitamin B_{12} supplement: 400 μg./100 lb. $MnSO_4$: 10 mg./100 lb.	100.00

Eggs which were laid on the last day of each weekly period (Table 6) were pooled by groups and analyzed for total arsenic. To determine total arsenic in the breast muscle, leg muscle, skin and livers, three pullets from each group were sacrificed at the end of the 14th week and three more at two intervals during the depletion period.

To determine arsenic, three or four eggs from each group were broken out and the contents well mixed in a Waring Blendor. Tripli-

TABLE 2—Antibiotic-free broiler ration

Ingredient	Composition
	Pounds
Ground yellow corn	58.40
Soybean oil meal	35.00
Dehydrated alfalfa meal	2.50
Steamed bonemeal	2.50
Oystershell flour	1.00
Salt (iodized)	0.25
Fish oil (600D, 2250A)	0.20
Vitamin mixture 2-49C	0.15
Total	100.00
Other ingredients:	
Choline chloride	17.0 gm.
Crystalline vitamin B_{12}	0.3 mg.
$MnSO_4$	10.0 gm.

cate samples of 20 grams each were analyzed for arsenic by the procedure of Evans and Bandemer (1953). Triplicate samples of 20 grams each were used for the muscle and liver analyses and those of 10 grams each for the skin. The procedure of Evans and Bandemer (1953) for eggs was also used for these tissues.

RESULTS AND DISCUSSION

The effect of graded levels of arsanilic acid on the maintenance of body weight of pullets and males is presented graphically in Figs. 1 and 2. A period of approximately 5 weeks was required for the pullets to adjust to the all-mash diet, after which body weight was maintained or increased. Arsanilic acid at the level of 90 grams per ton of feed did not alter the body weights, but 180 grams of arsanilic acid per ton of feed appeared to be marginal for body weight maintenance as evidenced by the notable weight gains during the depletion period.

The effect of graded levels of arsanilic acid on male body weights, however, was more marked. The males from pen 2 (90 gm./ton) and pen 3 (180 gm./ton) lost 300 and 240 grams in weight, respectively. This loss should be attributed to the effects of arsanilic acid rather than to the birds having been deprived of whole grains, for three reasons: 1) the male in pen 1 on the basal ration maintained its body weight, 2) the losses were most noticeable soon after arsanilic acid

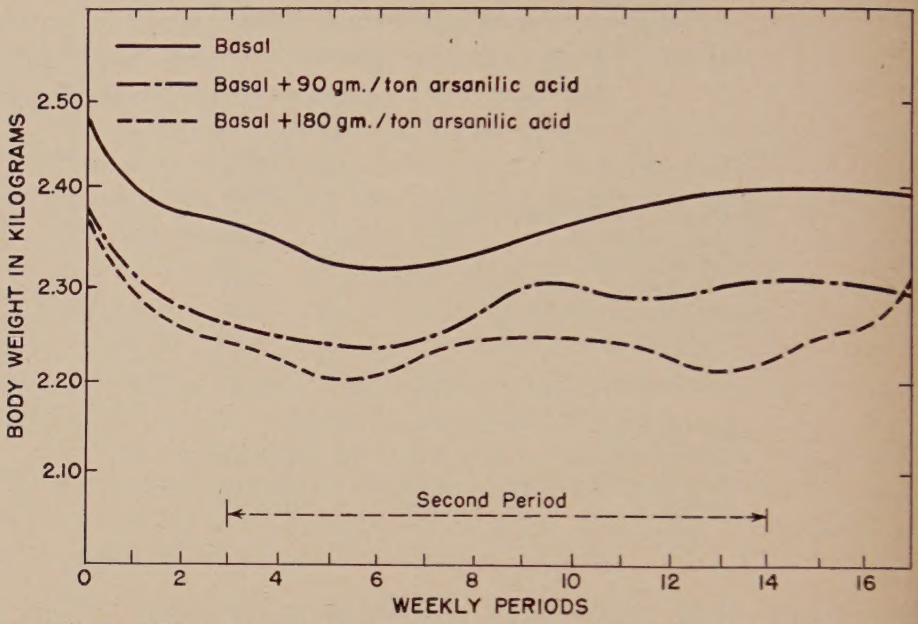
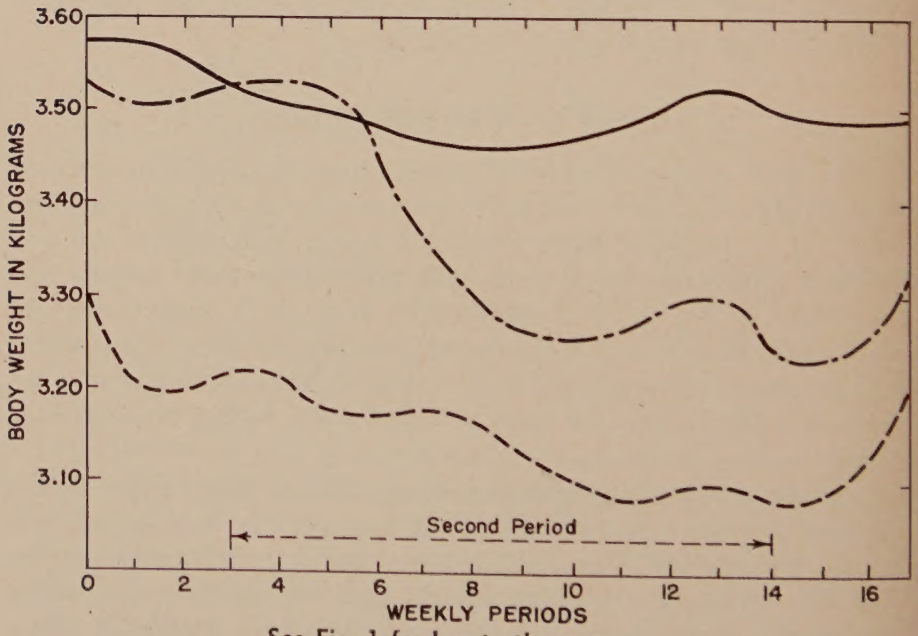


Fig. 1. Effect of graded levels of arsanilic acid on body weight maintenance of pullets.



See Fig. 1 for key to the curves.

Fig. 2. Effect of graded levels of arsanilic acid on body weight maintenance of males.

was incorporated in the ration and, 3) the rapid gains after the withdrawal of arsanilic acid. It must be kept in mind, however, that these data were obtained on single males and may have been fortuitous.

Egg production (Table 3) in general was low because many of the pullets selected either were in molt or entered into molt soon after the change of rations and groupings. Data on egg production are not presented for the depletion period because of the removal of the pullets for tissue analysis. Egg production of pen 2 (90 gm./ton) was not changed, whereas that of pen 3 (180 gm./ton) was 8 percent greater than during the initial 3-week period. The increase is due to the fact that production was very low while this group was on the basal ration.

TABLE 3—Effect of arsanilic acid on egg production (hen-day basis)

Week	Percent production		
	Group 1	Group 2	Group 3
First period			
1st	34.3	50.0	33.3
2nd	34.3	35.7	32.1
3rd	42.9	45.0	30.0
Average	37.2	43.9	31.8
Second period			
4th	35.0	43.6	34.3
5th	37.9	42.9	38.6
6th	30.7	39.3	36.4
7th	46.2	30.7	32.8
8th	35.7	36.4	37.1
9th	37.8	36.4	40.7
10th	39.3	42.8	43.5
11th	39.3	49.4	46.4
12th	40.2	46.4	52.8
13th	45.0	47.1	46.4
14th	35.0	32.1	40.7
Average	38.6	40.3	41.4

Table 4 shows that, at the levels used and during the length of time it was administered, arsanilic acid had no significant effect on the hatchability of fertile eggs. All eggs which did not hatch were broken out to determine the day and cause of embryonic mortality. There was no change percentagewise in embryonic mortality in terms

TABLE 4—Effect of arsanilic acid on the hatchability of fertile eggs

Week	Percent hatchability		
	Group 1	Group 2	Group 3
First period			
1st	73.4	93.5	97.1
2nd	89.0	86.0	91.9
3rd	92.1	69.3	91.1
Average	85.3	82.0	93.4
Second period			
4th	75.0	86.7	88.1
5th	82.4	89.9	88.2
6th	88.6	91.9	85.7
7th	88.4	82.1	93.5
8th	81.0	62.5	83.3
9th	88.6	82.9	91.1
10th	93.6	89.5	89.4
11th	91.6	92.5	89.8
12th	82.0	89.8	94.6
13th	88.0	87.0	86.4
14th	91.6	82.4	90.7
Average	86.5	85.8	88.9
Depletion period			
15th	90.0	89.0	84.9
16th	74.5	70.9	69.5
17th	81.5	90.0	83.3
Average	81.6	83.6	79.3

of day of death, nor did any dead embryos evidence teratological appearances attributable to arsanilic acid.

The early growth of chicks (Table 5) to 14 days of age was not influenced in any manner by the carryover of arsanilic acid in the egg, although the arsenic content of the eggs in the 7- to 13-week period greatly exceeded normal arsenic values in eggs (Table 6). Survival among chicks to 2 weeks of age was excellent in all groups—97.7, 98.1, and 98.5 percent, respectively, for chicks from pens 1, 2 and 3.

A definite deposition of arsenic occurred in the eggs and all tissues analyzed of groups 2 and 3 (Table 6). During the depletion period the arsenic content of the eggs and tissues of these groups fell rapidly to normal values, indicating that a 3-week depletion period is suffi-

TABLE 5—Effect of arsanilic acid in the maternal diet on early growth of chicks (Weight in grams to 2 weeks)

Grams arsanilic acid per ton of feed in the maternal ration →		Group 1 0	Group 2 90	Group 3 180
Week*	Period			
3rd	First	97.5	108.0	97.3
8th	Second	90.7	100.2	89.8
9th	Second	84.5	101.9	91.2
11th	Second	82.1	93.2	88.2
14th	Second	89.0	101.9	90.4

*The week of the experiment when eggs were collected to be hatched.

cient—in fact, may be longer than necessary—to remove surplus arsenic from the body of the chicken if this arsenic has been supplied in the form of arsanilic acid.

The level of arsenic in the eggs and tissues was proportional to the level of arsanilic acid in the feed. Maximum amounts of arsenic as tolerated by the Federal Food and Drug Administration (3.5 p.p.m. As_2O_3, or 2.65 μg, arsenic per gram) (Michigan Department of Agriculture, 1941) were not found in any tissues or eggs analyzed at any time during the experiment. However, the amounts found in the livers at the 14-week interval were high, and—in view of the higher levels of arsenic observed in eggs at this time—it is conceivable that at earlier stages they might have been still higher. Studies are being initiated to obtain this data.

SUMMARY

Quantitative data on the deposition of arsenic in eggs and tissues of pullets as a result of feeding graded levels of arsanilic acid were obtained during a 17-week period.

The body weight of the pullets was not significantly affected by the use of this chemical, nor was egg production. The hatchability of fertile eggs was not influenced by the addition of arsanilic acid to the ration during the 11-week experimental period. Arsanilic acid in the maternal diet did not affect the early growth of chicks on a practical broiler mash. Accumulation of arsenic in eggs and tissues was well below allowable levels and was proportional to the amount

TABLE 6—Arsenic content of eggs and hen tissues in micrograms/gram

Grams arsanilic acid per ton of feed →		Group 1 0	Group 2 90	Group 3 180
Week*	Period			
Arsenic in eggs (μg./gm.)				
3rd	First	0.010	0.003	0.003
7th	Second	.000	.246	.403
11th	Second	.000	.200	.352
13th	Second	.000	.116	.289
16th	Depletion	.005	.003	.013
17th	Depletion	.000	.000	.001
Arsenic in livers (μg./gm.)				
14th	Second	0.071	0.862	1.334
16th	Depletion	.034	.056	.104
17th	Depletion	.040	.033	.058
Arsenic in breast meat (μg./gm.)				
14th	Second	0.021	0.081	0.154
16th	Depletion	.012	.030	.047
17th	Depletion	.020	.018	.032
Arsenic in leg meat (μg./gm.)				
14th	Second	0.055	0.113	0.173
16th	Depletion	.040	.048	.064
17th	Depletion	.061	.033	.061
Arsenic in skin (μg./gm.)				
14th	Second	0.003	0.118	0.206
16th	Depletion	.010	.072	.144
17th	Depletion	.016	.035	.036

*The week of the experiment when samples were taken.

included in the ration. Arsenic in the eggs and tissues was practically eliminated in a three-week depletion period.

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CICADAS (LOCUSTS) WILL BE A PEST IN 1953

By RAY HUTSON
DEPARTMENT OF ENTOMOLOGY

ORCHARDISTS, nurserymen and other growers of broad-leaved deciduous trees need to plan for the appearance of a brood of the 17-year cicada or "locust" in May and June of 1953.

This insect is a holdover from the days when forests covered the state, and as a consequence will be most abundant in those areas where stands of oak remain or stood until the last 30 to 40 years. The insect, as the name indicates, appears once every 17 years. The last appearance was in 1936.

At that time the females deposited eggs in large scars running 2-3 feet along the smaller branches. The eggs hatched in July 1936, and since that time the young cicadas (nymphs) have fed on the roots of the trees on which the eggs were laid. The dark adult insects, approximately 1 inch long with heavy-appearing bodies and four clear wings distinctly marked with orange along the edges and wing veins, will announce their appearance by their characteristic shrill song, "pha-a-ro". The din created by the cicadas because of their numbers will be very noticeable. The damage the females cause by their egg-laying will also be noticeable because the multiple egglaying punctures weaken small branches (¼″ to ⅝″) causing "flags" of dead leaves on the trees attacked. Adult cicadas do not feed appreciably. The loss of small branches may or may not be serious for bearing trees. However, in the case of recently set or small trees the damage by cicadas is a serious setback.

Inasmuch as entomologists have an opportunity to attempt control of this pest only at 17-year intervals, experience gained with the insecticide control of cicadas in Michigan must be supplemented by information from other states in which the cicadas have appeared more recently than here. Most of the newer contact insecticides will kill some cicadas. The best material is tetraethyl pyrophosphate (TEPP) for both "knockdown" and final kill. One-half pint of 40-percent TEPP

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in 100 gallons of spray with a commercial spreader, repeated two or three times, will give excellent protection of bearing trees. It will not kill every cicada because of migration of the insects and because this insecticide has no appreciable residual effect. There is no known insecticide that will protect trees for more than a day or so.

Small broad-leaved ornamental or orchard trees pose a critical control problem because it is impossible to spray them often enough to protect them economically. Recently set plantings constitute a problem especially because the severe possible injury in heavily cicada-infested areas may result in a severe setback to the growth of the trees, or cause misshapen trees or the necessity of replanting. In areas known to have had a heavy infestation of cicadas in 1936, plantings of susceptible trees should be made with the knowledge that protective measures will be necessary to avoid loss. Experience has shown that the only positive way to protect small susceptible trees is to swathe each one loosely with ⅔ yard of cheesecloth, tobacco cloth, or similar porous fabric. This is a different approach to insect control than which is commonly employed, but for small trees it has proved to be an economical, sure, "one-shot" operation.

RELATIONSHIPS BETWEEN TEST WEIGHT AND CERTAIN MALTING QUALITY CRITERIA IN BARLEY[1]

By KENNETH J. FREY
DEPARTMENT OF FARM CROPS

ONE OF THE MAJOR criteria used by local grain buyers to determine whether a lot of barley should be bought as malting barley is the test weight per bushel. The test weight, by which malting barley is differentiated from feed barley, is usually about 44 pounds a bushel, with the high-test-weight lots being bought for malting purposes. The weight of barley is used for two reasons: first, it is easy to determine, and second, there seems to be some relationship between percentage of thin kernels, an undesirable factor, and test weight.

In view of the foregoing facts, it seemed desirable to investigate any relationships which might exist between test weight and certain malting quality criteria in barley. These criteria were malt diastatic power, malt extract and barley protein percentages, and the percentage of thin kernels.

MATERIALS AND METHODS

The barley samples used for this study were obtained from experiments designed to test the yield interaction of barley varieties and different fertilizer treatments. The experiments were conducted in the Saginaw valley district of Michigan for 3 years, 1949-51, inclusive. In 1949 the test included four varieties treated with five fertilizers of different analysis, in 1950 there were five varieties and five fertilizers, and in 1951 there were four varieties each treated with five rates of the same fertilizer.

The barley samples used for test weight and malting determinations were obtained by compositing the grain for each variety-fertilizer treatment from four replications. The samples were malted by the

[1]This study was supported in part by a grant-in-aid from the Midwest Barley Improvement Association.

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George J. Meyer Malt and Grain Corporation of Buffalo, New York, in 1949; by the Joseph Schlitz Brewing Company of Milwaukee, Wisconsin, in 1950, and by the Froedtert Grain and Malting Company of Milwaukee, in 1951. The malts were analyzed for extract percentage and diastatic power according to the methods of the American Society of Brewing Chemists.[2] Protein determinations, using a modification of the Kjeldahl procedure,[3] were made on the barley grain.

TABLE 1—Correlations of test weight with various malting quality criteria in barley

Year	Correlation between test weight and:			
	Protein %	Extract %	Diastatic power	% thin kernels
1949*.....	0.159	0.0	−0.012	−0.365
1950†.....	.229	.266	.273	− .174
1951‡.....	− .345	− .590**	.063	− .029

* = 35 d.f.
† = 20 d.f.
‡ = 16 d.f.
** = significant at the 1% level.

EXPERIMENTAL RESULTS

The intravarietal correlation coefficients between test weight and protein percentage, extract percentage, diastatic power, and percentage of thin kernels are presented in Table 1. Only one of the correlations is significant, that being a negative one between test weight and extract percentage in 1951. However, the other correlations involving these two factors are neither negative nor significant, indicating no consistant relationship. Even though none of the correlations between test weight and percentage of thin kernels is significant, they are all negative, indicating a slight inverse relationship between test weight and percentage of thin kernels. It is surprising, in view of past experience, that the correlations involving thin kernels are not higher. As mentioned earlier, one of the major reasons for using test weight as a criterion of malting barley is that low-test-weight samples are found to contain a higher content of thin kernels. In this study the range of thin kernel percentages was from zero to 5. The comparisons involving protein percentage and diastatic power are neither consistant nor

[2]Methods of analyses of the American Society of Brewing Chemists. 5th ed. Revised 1949.
[3]American Society of Brewing Chemists (1949). *Methods of Analyses of the American Society of Brewing Chemists.* 5th ed., revised. Univ. of Wisc. Press, Madison.

significant, which indicates that there is no relationship between test weight of barley and either of those factors.

On the basis of the barley samples used in this study, it appears that high test weight in barley does not necessarily indicate good malting quality as measured by malt extract percentage, malt diastatic power, or barley protein percentage. The barley test weights varied from 43.0 to 49.0 pounds per bushel, with a maximum range in any year being 3.5 pounds; the greatest range in a variety within any year was 3 pounds per bushel.

One of the ways by which test weight can be increased in barley is by close threshing which results in a minimum of awn remaining on the tip of the kernel. Oftentimes barley is threshed so close as to result in a high percentage of skinned, frayed, and broken kernels. Malsters prefer to have a few awns remaining on the barley kernels instead of a high content of skinned kernels because the latter result in malt which is incompletely modified and, thus, inferior in quality. On the other hand, thin kernels can be removed with the proper cleaning equipment: thus not affecting the malt quality.

From the data and discussion it appears that a medium-test-weight barley may be more desirable for malting purposes than one with a high test weight. This is true because barley with high test weight has no advantage over light- or medium-test-weight lots in desirable protein and extract percentages or diastatic power, and furthermore the high-test-weight lots are likely to contain an abundance of skinned, frayed, and broken kernels.

WINTER BARLEY VARIETIES FOR SOUTHWESTERN MICHIGAN

By KENNETH J. FREY
DEPARTMENT OF FARM CROPS

PROBABLY the most hazardous factor in winter barley production in Michigan is winter killing. Most attempts to grow winter barley in southern Michigan, where the average winter temperature is below 30° F., have been unsuccessful. The notable exception to this has been in Cass, Berrien, Van Buren, Ottawa and Allegan Counties where the climate is tempered by Lake Michigan. Current annual winter barley acreage in these counties is approximately 7,000 acres, of which 56 percent is planted to Wong, 23 percent to Michigan Winter, and 21 percent to various other varieties.[1]

In order to determine the best variety of winter barley for this area, the Farm Crops Department of the Michigan Agricultural Experiment station, in cooperation with the county agricultural agent,[2] conducted trials in Cass County during the years 1950-52 inclusive. The number of varieties and experimental strains included in these tests ranged from 10 to 16.

HOW WINTER BARLEY VARIETY TRIALS ARE CONDUCTED

Winter barley strains included in the variety yield trials demonstrated a high degree of winter survival in the nursery at East Lansing.

The experimental plots were four drill rows wide and 16 feet long, each variety being replicated four times. Lodging percentages were recorded from the two center rows of each plot on the basis of the plants which leaned more than 45 degrees from the vertical. Grain yields and test weights were likewise determined from the two center rows. Relative maturity and winterhardiness were obtained from tests conducted at East Lansing, Michigan.

[1]Michigan Crop Reporting Survey, 1952.
[2]R. O. Bittner.

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EXPERIMENTAL RESULTS

The summarized data from the winter barley yield trials grown in Cass County are presented in Table 1. Wong has been for several years the most popular winter barley variety and was therefore used as the standard with which to compare other varieties. All six varieties showed satisfactory winter hardiness in the trials in Cass County; however, none of the winters during the test period was severely cold. From the data recorded at East Lansing, where few winter barley varieties normally survive, it appears that Reno, Hudson, or Kenbar were more winter hardy than Wong.

Wong, Hudson, and Kenbar had very stiff straw, whereas Reno, Brier, and Purdue 1101 lodged considerably. Resistance to lodging is a critical factor in winter barley production because the lodged grain is difficult to harvest. From the viewpoint of resistance to lodging, Hudson, Kenbar or Wong would be the proper varieties to grow on soil with average or high fertility.

TABLE 1—Average yields, test weights, lodging and winter survival percentages of the winter barley varieties grown in tests in Cass County, 1950 to 1952 inclusive

Variety	Number years tested	Yield bushel acre	Test weight Lb./Bu.	Lodging %	Percent of plants surviving winter*
Wong	3	52.5	46.5	0	53
Reno	2	47.0	47.1	46	79
Brier	3	55.7	45.7	42	..
Purdue 1101	3	47.8	44.6	34	..
Hudson	2	59.3	47.9	3	75
Kenbar	2	59.6	42.3	5	75

*Winter survival notes were taken at East Lansing.

The best-yielding varieties of winter barley were Hudson and Kenbar, with average yields of approximately 59 bushels per acre which is a very satisfactory yield. This was 7 bushels greater than the yield of Wong and 12 bushels better than either Reno or Purdue 1101. When winter killing is negligible the yield of winter barley grown in southwestern Michigan is generally quite high.

The test weights of the winter barley varieties are higher than those of spring barley grown in the same region. Hudson, Reno, and

Wong were the varieties with the best test weights, averaging between 46 and 48 pounds per bushel, whereas Kenbar with 42.3 pounds was the lowest. Usually the varieties which produce a light test weight also produce a high percentage of hull remaining on the grain.

Generally winter barley matures about 20 days before winter wheat and 30 days before spring oats. Of the six varieties listed in Table 1, Wong is the latest while the others are medium in maturity. There may be some advantage in growing an early winter barley variety when it is used as a nurse crop; also, the early varieties do not interfere so much with hay making.

VARIETAL EVALUATIONS

VARIETIES RECOMMENDED

Hudson—This is a new variety of awnless winter barley, selected in New York state from the cross Wong × Michigan Winter. It produces high yields of good-test-weight grain. Hudson is stiff strawed and has acceptable winter hardiness when compared with other varieties. Certified seed for commercial planting of this variety will be available for Michigan farmers in the fall of 1954.

Wong—This is an awnless variety with exceptionally stiff straw. It matures late and appears to be somewhat less winterhardy than Hudson. Wong produces good yields of high-test-weight grain. This variety is not certified in Michigan. It is recommended that farmers growing Wong should replace it with Hudson as soon as seed of the latter variety is available.

Kenbar—This variety is a bearded type selected in Kentucky. It produces high yields, and is stiff strawed and winterhardy, but produces light-test-weight grain. Kenbar is not certified in Michigan.

VARIETIES NOT RECOMMENDED

Brier—This variety is not recommended for planting in Michigan because it is very susceptible to lodging.

Reno and **Purdue 1101**—These varieties have produced weak straw and inferior yields in the Michigan trials.

GROWTH OF TWELVE-WEEK-OLD CHICKENS NOT AFFECTED BY SIZE OF EGGS

By E. W. HENDERSON[1]
DEPARTMENT OF POULTRY HUSBANDRY

A PREVIOUS REPORT[2] revealed that weight of broilers at 8 weeks was not influenced significantly by the weight of eggs from which the broilers were hatched. It is well known that egg weight does not necessarily indicate mature weight either, but many breeds and strains differ significantly from one another as they approach and after they attain mature weight. Since the first 8 weeks of a chicken's life is only about one-third of its total growing period, there may be some question as to whether weight at 8 weeks marks an adequate test age. Since 12 weeks is roughly one-half of the total growing period of chickens, the 12th week may be a more pertinent measuring point. The 12th week is of course a more popular marketing age for broiler chickens.

Skoglund *et al.*,[3] in a study of egg weight-broiler weight relationships in the New Hampshire breed, used both the 8th and the 12th week as a test period. They found a very slight relationship between broiler weight and the smallest eggs set. Their findings were not confirmed in other breeds by the Michigan station nor by the Oklahoma station with the New Hampshire breed.

OBJECT

The object of this paper is to report egg weight-broiler weight relationships of several breeds and crosses of chickens at 12 weeks of age.

METHODS

The method of analysis of the data is by means of correlation coefficients calculated between the weight of individual eggs and the

[1]Assoc. Prof. J. A. Davidson and Asst. Prof. C. C. Sheppard assisted in routine management and breeding of flocks in 1940 and in 1948-52, respectively.
[2]Henderson, E. W. (1953). Is the size of broilers affected by the size of eggs from which they are hatched? Mich. Agr. Expt. Sta. Quart. Bul. 35:405-409.
[3]Skoglund, W. C., K. D. Seegar and A. T. Ringrose (1952). Growth of broiler chicks hatched from various sized eggs when reared in competition with each other. Poultry Sci. 31:796-799.

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subsequent weight of chickens hatched therefrom at 12 weeks of age. Every egg used in this experiment was pedigree marked and set in an individually closed compartment so that the ancestral origin of each chick could be determined accurately. All chicks were marked with numbered, sealed wing bands. Comparable lots of chicks were hatched in the same incubator at the same time. They were grown in the same brooders and given identical feed mixtures. Weights were taken on the same dates in each lot.

PARENTAL STOCK

The parental stock from which the eggs of this report were obtained was in part identical with that mentioned in the report of Henderson.[4] Some of the records analyzed were obtained in 1940 before the advent of so-called high-energy feeds. Since the records of Skoglund and associates[5] were obtained recently with faster growth-producing diets, considerable recent data were added to the original study. The use of the growth attained at 12 weeks of age may be logical for other than market reasons. It is well known that breeds and strains of chickens vary in rate of growth up to certain ages. As an example, at this station the White Leghorn strain is known to grow as fast up to the 8th week of age as does the Dark Cornish. It is well known, of course, that the Dark Cornish breed weighs considerably more at maturity than does the White Leghorn breed. The same type of variation exists among other breeds, so that a measure of rate of growth taken at one age may not be comparable to that at some other age. In the case of Leghorns versus Cornish, somewhere in the growth period the Cornish rate of growth (as measured by weight at a given age) exceeds that of the Leghorn breed. The same relationship is more-or-less true for Rhode Island Reds and Barred Rocks as compared with Leghorns and Cornish. The weights of cross-bred chicks which were hatched in 1948 and 1951-52 might not be considered comparable except for the fact that brooder chicks are necessarily grown in a controlled environment. Brooding temperatures are reasonably identical from year to year, and rations during the period 1948-52 did not differ seriously. Even though environmental conditions might not be considered comparable between years, any possible influence of hatching egg weight on growth would be apparent in the year when the eggs were set and chicks grown. If small eggs and resultant

[4] *Op. cit.*
[5] *Op. cit.*

small chicks are handicapped in growth with companion chicks, as postulated by Skoglund and associates,[6] the relationship should be measurable by a correlation analysis regardless of the year in which the chicks were grown.

RESULTS

The correlations between egg weight and subsequent broiler weight at 12 weeks are shown in Table 1.

TABLE 1—Correlations between egg weight and broiler weight

Number	Breed and age of dams	Breed of sires	Range of egg weight (grams)*	Sex of broilers	Correlation coefficient
20.....	W. L. pullets†.....	W. L.....	52-65	Male	0.07
30.....	W. L. pullets†.....	W. L.....	50-71	Female	−.01
26.....	R. I. R. pullets†....	R. I. R.....	52-70	Male	.18
24.....	R. I. R. pullets†....	R. I. R.....	50-68	Female	.36
25.....	B. R. pullets†.....	B. Rock.....	50-69	Male	.08
24.....	B. R. pullets†.....	B. Rock.....	52-70	Female	.04
27.....	W. L. hens.....	D. Cor.....	54-73	Male	−.01
24.....	W. L. hens.....	D. Cor.....	54-70	Female	.21
36.....	B. R. hens.....	W. Cor.....	59-70	Male	−.14
26.....	B. R. hens.....	W. Cor.....	59-71	Female	.18
71.....	Combined pullets†..	Standard bred...	50-70	Male	.06
78.....	Combined pullets†..	Standard bred...	50-71	Female	.12
35‡.....	Misc. Cross-breds†.	Cross-breds.....	50-64	Male	−.04
58‡.....	Misc. Cross-breds†.	Cross-breds.....	48-66	Female	−.17

*One ounce = 28.29 grams.
†Approximately one year of age.
‡Seasons of 1948 and 1951-52.

None of the correlation coefficients in Table 1 proved to be significant (by standard statistical procedure). In other words, large eggs and large broilers were not associated any more often than which might occur by chance. Some of the coefficients are negative, which would indicate a reverse relationship if they were statistically significant. The relatively high negative correlation in one case is the result, in part, of a sample from a New Hampshire-Cornish (large-egg strain) when crossed on Cornish-Leghorn (small-egg strain). For example, one small sample of 10 eggs of the 1948-52 data averaged 44 grams in weight (18 ounces per dozen) but resulted in chicks which averaged over 4 pounds at 12 weeks.

[6] *Op. cit.*

The "combined pullets" class in Table 1 is the result of pooled data from three breeds—Leghorns, Rhode Island Reds and Barred Rocks—which did not differ significantly (by analysis of variance) in average egg weight. The resultant correlation coefficients were very low (0.06 and 0.12) and not significant in spite of the fact that the relationship between egg weight and 12th week chick weight in this particular strain of Rhode Island Reds was high (0.36) among females and fairly high (0.18) among the males. The eggs from Barred Rock hens bred to White Cornish males were not included in the pooled sample because both egg weight and broiler weight differed significantly from that of the pullets. The eggs from White Leghorn hens bred to Dark Cornish males were not included for the same reason.

IMPLICATIONS OF RESULTS

The failure to obtain a single significant correlation coefficient among 14 samples from a total of 355 eggs (and their resultant broilers) would seem to indicate that there is little, if any, relationship between the weight of eggs and the weight, at 12 weeks of age, of broilers hatched from those eggs. In other words, the genetic potential of chicks was not affected by the weight of the eggs, within the limits of 18 ounces per dozen and 27 ounces per dozen. If eggs are small merely because the pullets which laid them are immature there seems to be no biological objections to their use for the production of broiler chicks. The results of this study, however, should not be interpreted to sanction the indiscriminate use of small eggs for hatching purposes. Bantam eggs will result in Bantam broilers, but "Bantam" broilers can be obtained also from large eggs of *slow-growing strains.*

FUNGICIDE COMBINATIONS IN TANK-MIX SPRAYS FOR TOMATOES[1]

By M. C. STRONG
DEPARTMENT OF BOTANY AND PLANT PATHOLOGY

IN THE PRODUCTION of canning and market tomatoes, the two principal fungous disease problems are those caused by the ripe fruit spot which is known as anthracnose and the so-called blights. The latter comprise a group of three leaf diseases: early blight, late blight and Septoria blight. Early and late blight fungi produce a characteristic fruit rot in addition to destroying foliage.

Experience has shown that timely applications of ziram (zinc dimethyl dithiocarbamate) give good control of anthracnose and the use of insoluble copper fungicides provides adequate control of the three blight diseases. Consequently, a standard control recommendation has been an alternating schedule of sprays or dusts, with a copper fungicide applied at one time, followed a week or 10 days later by a ziram application. This schedule is often confusing to follow and unfortunately leaves too long a time interval between applications of copper or ziram for good disease control.

In an earlier publication,[3] the author described the results of preliminary trials of tank-mix sprays and dust mixes of the copper and ziram types of fungicides in the same application. The results obtained with tank-mix sprays were promising enough to warrant further testing, and the continuation of the tests is here reported.

1951 TESTS

Southern-grown plants of the Improved Garden State variety were used. Randomized plots of 20 plants were replicated four times for each treatment. The methods of culture employed and the manner of obtaining data have previously been described.[4]

[1]Contribution 53-5 from the Department of Botany and Plant Pathology, Michigan State College.
[2]The author wishes to thank the Joseph Campbell Company for the tomato plants used in these tests and the agricultural chemical companies that furnished fungicides and financial assistance.
[3]Strong, M. C. (1951). Preliminary tests of fungicide combinations in tomato sprays and dusts. Mich. Agr. Expt. Sta. Quart. Bul. 33: 320-325.
[4]Strong, M. C. (1950). Comparison of fungicidal sprays for the control of tomato blights. Mich. Agr. Expt. Sta. Quart. Bul. 32: 338-347.

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Five insoluble copper fungicides were compared alone and in tank-mixes with ziram. A zinc-dithane tank-mix and a manganese-dithane tank-mix were compared with and without the addition of ziram. Two types of ziram were compared: Zerlate, a wettable powder, and a tank-mix of Vancide 51 plus zinc sulfate.

Since ziram is known to react slowly with copper fungicides and produce a brown mixture containing copper carbamate, it seemed advisable to include in the test a tank-mix in which this reaction had taken place. This was done in order to determine whether such a reaction product might injure tomato plants or would have any fungicidal value. The reaction product was prepared by adding a wetting agent to a tank-mix of Zerlate and Tribasic Copper Sulfate and allowing the mixture to stand 8 to 10 hours, during which time the color changed from blue-green to brown.

To control hornworms, calcium arsenate was added at the rate of 2 pounds per 100 gallons to the first two applications of every treatment. Check plots were also sprayed twice with this insecticide.

Spray applications were made on July 24, August 6, 18 and 30, and on September 8 and 18. The first picking was made on August 25 followed by eight more, the last being on September 28. A killing frost occurred September 29.

Early blight was first observed July 24 and continued to build up throughout the season. On August 7 all plots were seeded with specimens of late blight collected in Lenawee County and on August 10 with specimens of Septoria blight collected in Indiana. All three blights were abundant on untreated, control plots. Fruit showing late blight infection appeared in the third picking, and by the middle of September there were few uninfected fruit in the untreated plots. Anthracnose was present from the first of September to the end of the season, but was relatively unimportant in comparison with late blight.

Results of this test are summarized in Table 1. The photographs in Fig. 1 show the extent of defoliation of an untreated control plot, as compared with plots sprayed with various fungicides.

DISCUSSION OF RESULTS

No treatment entirely prevented early blight, but nearly all provided satisfactory control. The two types of ziram, Zerlate (wettable powder) and Vancide 51 plus zinc sulfate compared very favorably with one another as to yield and reduction in anthracnose infection.

TABLE 1—Summary of 1951 tomato fungicidal spray trials

Treatment	Formula	Total yield per acre	Percentage of culls	Percentage of defoliation Sept. 27, 1951
		Tons	*Percent*	*Percent*
Control	Untreated	5.6	31.5	85
*Cop-o-zinc	4 lb.—100 gal.	10.4	6.1	14
Cop-o-zinc + Zerlate (tank-mix)	4 lb., 2 lb.—100 gal.	10.6	5.6	11
†COCS (copper oxychloride sulfate)	4 lb.—100 gal.	8.7	6.3	13
COCS + Zerlate (tank-mix)	4 lb., 2 lb.—100 gal.	11.1	5.7	9
‡Crag 658	2 lb.—100 gal.	9.2	5.9	11
Crag 658 + Zerlate (tank-mix)	2 lb., 2 lb.—100 gal.	10.5	6.1	13
§Robertson copper	2 lb.—100 gal.	8.7	6.4	11
Robertson copper + Zerlate (tank-mix)	2 lb., 2 lb.—100 gal.	10.9	5.9	10
*Tribasic Copper Sulfate	4 lb.—100 gal.	8.3	5.8	13
Tribasic Copper Sulfate + Zerlate (tank-mix)	4 lb., 2 lb.—100 gal.	11.4	5.9	10
Copper carbamate (tank-mix reaction product)	4 lb. Tribasic Copper Sulfate + 2 lb. Zerlate—100 gal.	9.5	6.3	10
¶Dithane 14 + $ZnSO_4$ (tank-mix)	2 qt., ¾ lb. $ZnSO_4$—100 gal.	8.7	6.0	10
Dithane 14 + $ZnSO_4$ + Zerlate (tank-mix)	As above + 2 lb. Zerlate	8.2	5.8	13
Dithane 14 + $MnSO_4$ (tank-mix)	2 qt., 1 lb. $MnSO_4$—100 gal.	8.5	6.4	11
Dithane 14 + $MnSO_4$ + Zerlate (tank-mix)	As above + 2 lb. Zerlate	7.9	6.2	10
**Vancide 51 + $ZnSO_4$	3 lb., 1 lb. $ZnSO_4$—100 gal.	9.2	19.7	24
††Zerlate	2 lb.—100 gal.	9.2	17.9	25
L. S. D.		1.5	2.3	7

*Manufactured by Tennessee Corp.
†Manufactured by Niagara Chemical Division, Food Machinery and Chemical Corp.
‡Manufactured by Union Carbide & Carbon Corp.
§Manufactured by H. H. Robertson Co.
¶Manufactured by Rohm and Haas Co.
**Manufactured by R. T. Vanderbilt Co.
††Manufactured by E. I. du Pont & Co.

Fig. 1. A comparison of four 1951 plots: upper left, untreated control; upper right, sprayed with Tribasic Copper Sulfate; lower right, sprayed with an unreacted tank-mix of Tribasic Copper Sulfate plus ziram; lower left, sprayed with the same tank-mix reaction product containing copper carbamate.

Both failed to control late blight, whereas all other treatments showed good control. The addition of ziram to insoluble copper fungicides in a tank-mix resulted in significantly higher yields than was true when the comparable copper fungicide was used alone, except for those copper fungicides containing zinc (Cop-o-zinc and Crag 658). However, the percentage of culls was not significantly reduced by the addition of ziram to copper fungicides. This indicates that in 1951 the principal effect of ziram was that of zinc stimulation. In the 1950 test, when anthracnose was a major disease, the addition of ziram to copper fungicides not only increased yields but reduced the percentage of culls as well.

The addition of ziram to either zinc- or manganese-dithane showed no advantage as to disease control and had the disadvantage of overstimulating foliage production, with a consequent delay in fruit ripening. This factor, combined with an early frost, resulted in an actual decrease in yield.

Copper carbamate, the reaction product of a tank-mix of Tribasic Copper Sulfate and ziram, provided good disease control but was intermediate in effect on yield. It resulted in a higher yield than Tribasic Copper Sulfate alone but a smaller yield than that obtained from the plots sprayed with the unreacted tank-mix of Tribasic Copper Sulfate and ziram. The indications are that even if a chemical reaction does take place in this tank-mix and copper carbamate is produced, disease control will still be maintained. Copper carbamate itself appears to be a good fungicide.

All yields in 1951 were relatively low because of a short picking season. All fungicides tested provided significant increases in yield over the untreated controls as well as significant decreases in percentages of culls and defoliation.

1952 TESTS

The variety of tomato, source of plants, and methods employed in 1952 were the same as in the previous trial, but a reduction in concentration of fungicides in the tank-mix was tested. Four insoluble copper fungicides plus Zerlate were compared in a tank-mix and in an alternating schedule of application (Z-C-Z-C-Z-C). Half the usual concentration of each fungicide was used in the tank-mix at each application during the season so that comparable plots received identical amounts of each fungicide but the method of application varied. Included in the tests was a tank-mix of Tribasic Copper Sulfate and

Zerlate, each at half strength, which had been allowed to react, with resulting production of copper carbamate.

One insoluble copper (COCS) was tried in tank-mixes with two forms of Vancide 51, a zinc salt and a manganese salt, as well as in combination with TMTD (tetramethyl thiuram disulfide). A third type of Vancide 51 tested was a mixture of zinc, manganese and copper salts. The three forms of Vancide 51 were compared with Zerlate.

Orthocide 406 (N-trichloro methylthio tetrahydrophthalimide), a new fungicide, was included in the 1952 tests. Polyethylene polysulfide was tested as a sticker with an insoluble copper fungicide.

For hornworm control, Marlate was added at the rate of 2 pounds per 100 gallons to the first two applications of all treatments. The check plots also received two applications of this insecticide.

Spray applications were made on July 21 and 31, August 13 and 23, and September 2 and 15. The first of 11 pickings was on August 15, and the last one on October 2. A killing frost occurred October 3.

The season was very dry. All plots were irrigated twice in July, but irrigation was then abandoned because of non-uniformity of application with the available equipment.

Alternaria blight was first observed July 21 and increased gradually throughout the season. Neither late blight nor Septoria were present in the test plots; nor were they prevalent in the state. Anthracnose appeared early in September and continued to be important during the remainder of the season.

The results are summarized in Table 2. The photographs shown in Fig. 2 illustrate the extent of defoliation in an untreated control plot in comparison with plots sprayed with various fungicides.

DISCUSSION OF RESULTS

As a result of "puddling" in certain areas during irrigation, uneven growth of plants was induced. This variable factor was reflected in the statistical analysis of the yield data, which revealed that differences between replications were sometimes as great as between various treatments. Hence, the difference in yields and percentage of culls obtained in this test were not statistically significant.

The insoluble copper sprays alternating with ziram applications resulted in slightly better yields than the corresponding tank-mix spray applications. However, the latter treatments improved the grade of fruit more than did the alternating spray applications. Both methods

TABLE 2—Summary of 1952 tomato fungicidal spray trials

Treatment	Formula	Total yield per acre	Percentage of culls	Percentage of defoliation
		Tons	*Percent*	*Percent*
Control	Untreated	6.5	18.2	23.0
Calumet and Hecla copper + Zerlate (alt.)*	2¾ lb., 2 lb.—100 gal.	11.0	6.1	10.2
†Calumet and Hecla copper + Zerlate (tank-mix)	1⅜ lb. + 1 lb.—100 gal.	10.1	5.9	7.7
Robertson copper + Zerlate (alt.)*	2.15 lb., 2 lb.—100 gal.	11.2	6.2	8.2
Robertson copper + Zerlate (tank-mix)	1.07 lb. + 1 lb.—100 gal.	10.9	5.6	8.0
Tenn. Tribasic Copper Sulfate + Zerlate (alt.)*	4 lb., 2 lb.—100 gal.	11.2	5.9	8.2
Tenn. Tribasic Copper Sulfate + Zerlate (tank-mix)	2 lb. + 1 lb.—100 gal.	10.7	5.5	9.2
Tenn. Cop-o-zinc + Zerlate (alt.)*	4 lb., 2 lb.—100 gal.	11.4	5.7	8.0
Tenn. Cop-o-zinc + Zerlate (tank-mix)	2 lb. + 1 lb.—100 gal.	10.0	5.6	8.0
Copper carbamate (tank-mix reaction product)	2 lb. Tenn. Tribasic Copper Sulphate + 1 lb. Zerlate—100 gal.	10.3	6.2	8.0
Niagara COCS	3 lb.—100 gal.	11.1	6.2	9.2
COCS + Vancide 51ZW (tank-mix)	1½ lb. + 1 lb.—100 gal.	10.8	6.8	8.2
COCS + Vancide 51F995W (tank-mix)	1½ lb. + 1 lb.—100 gal.	9.0	10.1	10.6
COCS + TMTD 75§ (tank-mix)	1½ lb. + ¾ lb.—100 gal.	9.3	10.8	9.0
Vancide 51ZW	2 lb.—100 gal.	10.5	7.2	12.5
Vancide 51F995W	2 lb.—100 gal.	8.7	9.9	24.0
Vancide 51F1056W	2 lb.—100 gal.	9.0	8.5	14.2
Zerlate	2 lb.—100 gal.	8.9	7.5	14.5
Tenn. Tribasic Copper Sulfate	4 lb.—100 gal.	10.1	6.2	7.5
Tenn. Tribasic Copper Sulfate + P.E.P.S.‡	4 lb. + ½ pt.—100 gal.	9.9	6.0	9.0
Orthocide 406	2 lb.—100 gal.	9.4	11.8	26.0
L.S.D.		ns	ns	4.9

*Alternating schedule.
†Manufactured by Calumet and Hecla Consolidated Copper Co.
‡Manufactured by B. F. Goodrich Chem. Co.
§Manufactured by Niagara Chemical Division, Food Machinery and Chem. Corp.

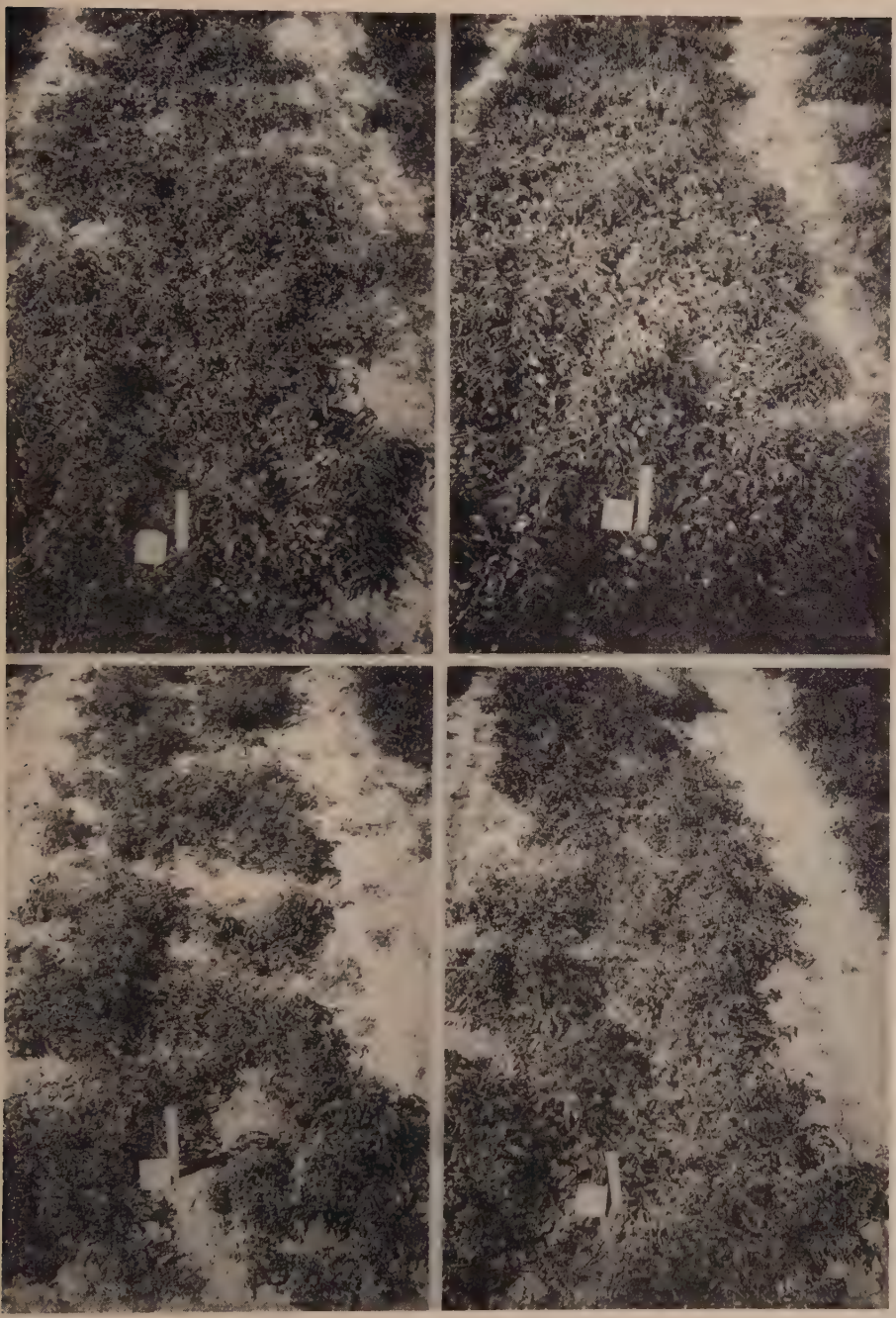

Fig. 2. A comparison of four 1952 plots: upper left, plot was sprayed with Robertson copper fungicide and Zerlate in an alternating schedule; upper right, the plot received the same fungicides in a tank-mix; lower right, the plot was given COCS plus Vancide 51ZW in a tank-mix; lower left, untreated check plot.

of application of copper plus ziram provided adequate control of early blight.

Yields and disease control resulting from applications of copper carbamate (the reaction product of a tank-mix of Tribasic Copper Sulfate and Zerlate) were comparable to those obtained with a similar unreacted tank-mix.

Plots sprayed with Vancide 51ZW outyielded those sprayed with the other two Vancide formulations as well as those treated with Zerlate. Vancide 51ZW also provided better disease control than the other Vancide formulations or Zerlate. Vancide 51ZW in a tank-mix with COCS gave results similar to those of the other insoluble copper fungicides plus Zerlate. The tank-mix of COCS and TMTD provided good blight control but stimulated foliage production, with consequent delayed fruit ripening which, in combination with an early frost, resulted in a slightly reduced yield as compared with the yields from the plots receiving the other tank-mix treatments. This combination did not control anthracnose as well as did combinations containing ziram.

The addition of polyethylene polysulfide (PEPS) as a sticker to Tribasic Copper Sulfate did not enhance the latter's value as a spray in this test. Under conditions of more rainfall which would subject foliage to greater washing action, this sticker might have proved of greater value.

Orthocide 406 was a less effective treatment than a copper fungicide plus ziram, either in an alternating schedule or tank-mix.

All treatments resulted in higher yields than the untreated control plots, and all reduced the percentage of culls below those of the untreated plots. All treatments except Orthocide 406 significantly reduced the percentage of defoliation below that obtained in the untreated control plots.

CONCLUSIONS

A tank-mix spray of an insoluble copper fungicide plus ziram may be substituted for the alternating schedule of these two fungicides on tomatoes. Calcium arsenate or Marlate may be added for hornworm control.

Although the copper fungicide and ziram may react to form copper carbamate in the tank-mix, it appears that disease control can be maintained with this mixture.

Spray applications should begin when the first cluster of fruit is set, and be continued at 10-day intervals thereafter. At least five applications should be made, six being preferable.

In the tank-mix each fungicide may be used at half the usual concentration until late blight appears on the plants. At that time, the copper portion of the spray should be increased to full recommended concentration or to the equivalent of 2 pounds of metallic copper per 100 gallons of spray mixture.

CONTROL OF WINTER ANNUAL WEEDS WITH 3-CIPC IN A STOOLBLOCK OF MALLING APPLE ROOTSTOCKS

By R. F. CARLSON and H. B. TUKEY
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BECAUSE OF AN INCREASE in demand for dwarf fruit trees there has arisen a corresponding increase in demand for dwarfing rootstocks upon which dwarf trees are propagated. Such rootstocks are raised in stoolblocks, by mound layering, in which the weed problem becomes serious. In fact, the first published results on the use of 2,4-D as a herbicide arose from applications to a stoolblock of Malling apple rootstocks infested with bindweed *(Convolvulus arvensis)*.[1]

Winter annual weeds, such as common chick weed *(Stellaria media)*, common mallow *(Malva rotundifolia)* and annual blue grass *(Poa annua)* are difficult to control by manual and cultural means. These and other weeds are not easily removed in the spring without injuring the rootstock, because at that time the young apple shoots are just emerging from the stool crown.

The results reported in this paper deal with applications of isopropyl N-(3-chlorophenyl) carbamate (referred to hereafter as "3-CIPC") for the control of winter annual weeds in a stoolblock of Malling apple rootstocks.

MATERIALS AND METHODS

Eighteen rows, 300 feet long, of a first-year stoolblock planting of Malling I, VII, IX and XVI growing on a Hillsdale clay loam soil were sprayed October 18, 1951 with 3-CIPC at the rates of 6, 12 and 18 pounds per acre. A mature stoolblock was similarly treated November 13 after the rooted shoots had been removed and the stool-crowns covered with an inch of soil. Some weeds were well established, and others were just emerging at the time the sprays were applied to the

[1]Hamner, C. L., and H. B. Tukey (1944). The herbicidal action of 2, 4-dichlorophenoxyacetic acid and 2, 4, 5-trichlorophenoxyacetic acid on bindwood. Science 100: 154-155.

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young plantings. However, no weeds were observable when the mature stoolblock was treated, since such vegetation was destroyed during the operation of mound-levelling and removal of the rooted shoots.

A relatively warm day, with temperatures ranging from 60° to 70° F., was selected for the application of the 3-CIPC. The sprays were applied to the row from both sides, at the rate of 60 gallons per acre, using a knapsack sprayer. In the young planting the lower 4 to 6 inches of the stems of the rootstock were touched by the spray. In the mature planting the spray was applied directly to the soil over the row from which the rooted shoots previously had been removed.

Weed counts were taken the following spring, May 18, and shoot-growth (current season's growth) was measured during October and November. Careful examination was made of all top growth and rooted shoots for any possible injury.

RESULTS

YOUNG PLANTING

An average of 79.3, 88.6 and 96.5 percent weed control was obtained from 6, 12 and 18 pounds of 3-CIPC per acre, respectively (Table 1, Fig. 1). Measurements and observations of the current season's growth revealed no injurious effect to the rootstocks at any of

TABLE 1—Percent weed control obtained from application of 3-CIPC at 6, 12 and 18 pounds per acre to stoolblocks of Malling rootstocks. Applications were made in the fall, weed counts were recorded in the spring, and shoot-growth measured the following fall

Pounds per acre 3-CIPC	Weed control (percent of check)	Average shoot growth of stock, in inches	
		Check	Treated
	Young Planting		
6	79.3	18.6	21.1
12	88.6	20.2	17.8
18	96.5	19.1	19.9
	Mature Planting		
6	82.4	16.8	16.2
12	85.1	17.4	18.0
18	93.4	17.0	16.9

Fig. 1. Control of winter annual weeds in a young stoolblock of Malling apple rootstocks by an application of 3-CIPC at the rate of 6 pounds per acre, made in the fall. (Left) unsprayed; (right) sprayed. Photographed the spring following application.

the concentrations used. Six pounds per acre of 3-CIPC was sufficient for satisfactory weed control, and three times that amount produced no visible toxic symptoms on the rootstocks.

MATURE PLANTING

Weed counts made in May showed 82.4, 85.1 and 93.4 percent control of winter annual weeds from applications of 6, 12, and 18 pounds per acre, respectively (Table 1). No injury was apparent to the rootstock from any of the applications although the highest (18 pounds) is a relatively high rate. The rooted shoots harvested in early November appeared unaffected in vigor and in number of roots formed as compared with shoots from untreated rows.

DISCUSSION AND CONCLUSIONS

The use of 3-CIPC at 6 pounds per acre, applied when the rootstock is dormant, appears to be satisfactory for control of many of the winter annual weeds in stoolblocks of Malling apple rootstocks. Although the results reported in this test deal only with fall applications, it is suggested that early spring applications may also be effective,

at a time when weeds are becoming active and rootstocks are still dormant.

In the timing of herbicidal sprays to stoolblocks of Malling rootstocks, distinction must be made between the newly established and the mature stoolblock. The newly established one is not cut back the first 2 years and may be sprayed in October. On the other hand, the mature stoolblock is levelled and cut some time later. Accordingly, the mature block cannot be sprayed until after the rooted shoots have been removed—usually in November.

When used under the cool soil and air conditions which prevail in late fall, 3-CIPC appears to persist in activity for a longer period than when used under the higher temperatures of summer.[2] From this point of view, the material seems especially well suited to use in stoolblocks as indicated.

Since a new planting of rootstocks is usually not mounded the first two seasons, this period might properly be used for weed control in order to help reduce labor costs in subsequent years when the block is in production.

All the rootstock materials observed (Malling I, VII, IX, and XII) appear equally tolerant of 3-CIPC at the concentration and under the conditions used in these tests.

[2]Stevens, L. F., and R. F. Carlson (1952). The effects of Chloro IPC on various crops and its residual properties in various soils. Proc. 6th Ann. Northeastern Weed Control Conf., pp. 33-44.

MOISTURE IN ORCHARD SOILS AS INFLUENCED BY AGE OF SOD AND CLEAN CULTIVATION

By A. L. KENWORTHY
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GRASS OR LEGUME SODS are used in over 75 percent of the Michigan apple orchards and in approximately 25 percent of the cherry and peach orchards. Such a grass or legume sod may reduce tree growth and production because of the utilization of available soil moisture by the sod cover. Hedrick (1914), Woodbury, Noyes, and Oskamp (1917), and Collison and Carleton (1942) reported evidence to indicate that soil moisture was reduced more by orchard sods than by clean cultivation. On the other hand, Gourley (1917), Anthony and Waring (1925), Baker (1936), and Toenjes (1941) found that there was as much or more moisture under orchard sods as in clean-cultivated soil.

The influence of orchard sods and clean cultivation upon soil moisture may be related to several factors. Age of sod, period of cultivation, type of soil, soil fertility, rainfall distribution, amount and intensity may be factors of primary importance. A study of soil moisture in relation to sod covers and clean cultivation was initiated at the Graham Horticultural Experiment Station, near Grand Rapids, in 1950.

PROCEDURE

A peach and a pear orchard were used in this study. The sod and clean cultivation practices had been established for 2 years in the peach orchard, and for 25 years in the pear orchard. Fescue sod was in the peach orchard, and a blue grass sod in the pear orchard. Both orchards were on a Miami silt loam. Plaster of paris soil moisture blocks (Bouyoucos and Mick, 1940) were placed at 8-, 24-, and 42-

[1]**Acknowledgment**—The author expresses appreciation to Mr. George Crabb, Jr., of the Michigan Hydrologic Research Station, U. S. Department of Agriculture, for assistance in making the installations and to Mr. W. Toenjes, of the Graham Horticultural Experiment Station, for assistance throughout the program.

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inch depths. Two installations were made in each sod and clean cultivation plot. The blocks were located between the trees so as to avoid as much as possible the influence of the trees upon soil moisture.[2] Weekly determinations of available soil moisture were made, using the direct-reading moisture meter.

RESULTS

The 1950 rainfall, as shown in Fig. 1, was above average in July, and below average in August, September, and October. Rainfalls on all but three days (July 17, July 20, and August 25) were less than one-half inch. Throughout the summer there was no rain that exceeded 1.6 inches.

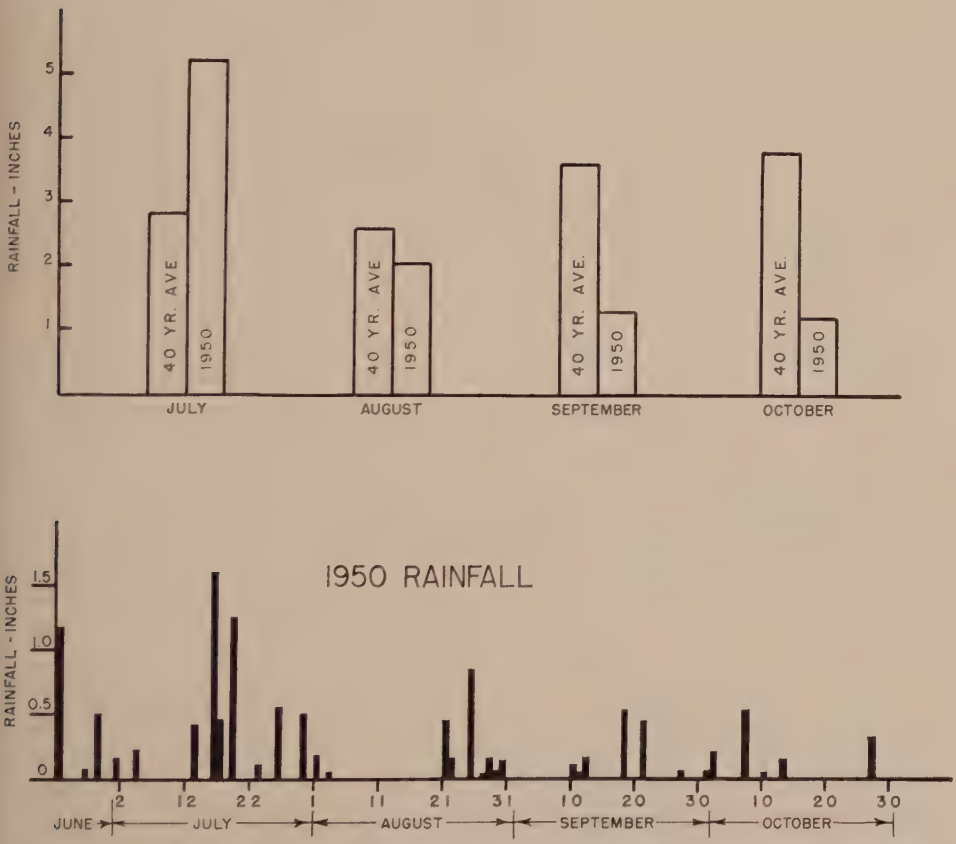

Fig. 1. Rainfall, amount and distribution for 1950 in comparison with the 40-year average (Graham Horticultural Experiment Station, near Grand Rapids).

[2]Another investigation showed that the depletion of soil moisture between trees is largely associated with the growth of the sod cover.

According to Table 1, more available moisture was present in the plots receiving treatment for 2 years than in the plots receiving treatment for 25 years. The available soil moisture under the 2-year-old sod was lower than in soil clean cultivated for 2 years. Available soil moisture under the 25-year-old sod was higher than in soil clean cultivated for 25 years. The soil under the 25-year-old sod contained more available soil moisture than did the soil under the 2-year-old sod. There was more available soil moisture in the soil clean cultivated for 2 years than in the soil clean cultivated for 25 years. These differences in available soil moisture were observed at all depths.

TABLE 1—Average percentage of available soil moisture present at 8, 24, and 42 inches in relation to sod and clean cultivation (June 27 to November 7, 1950)

Treatment	Depth of moisture block			
	8 in.	24 in.	42 in.	Average
After 2 years	*Percent*	*Percent*	*Percent*	*Percent*
Fescue sod	52	53	78	58
Clean cultivation	70	86	98	84
After 25 years				
Grass sod	71	73	72	72
Clean cultivation	45	44	49	46

The seasonal trends in available soil moisture (Figs. 2 and 3) show that there was a gradual decrease for all plots as the season progressed. The rains occurring between July 13 and August 1, and between August 21 and September 1 resulted in a slight increase in the average available soil moisture. Available soil moisture on July 31 was highest for the season on all plots, but did not reach field capacity at all depths except in the plot clean cultivated for 2 years. Less than 60 percent of the available soil moisture was present under the 2-year-old fescue sod after August 14. More than 60 percent of the available soil moisture was always present in the soil clean cultivated for 2 years. After September 11, less than 60 percent of the available soil moisture was present under the 25-year-old sod. After August 7, less than 60 percent of the available soil moisture was present in the soil clean cultivated for 25 years.

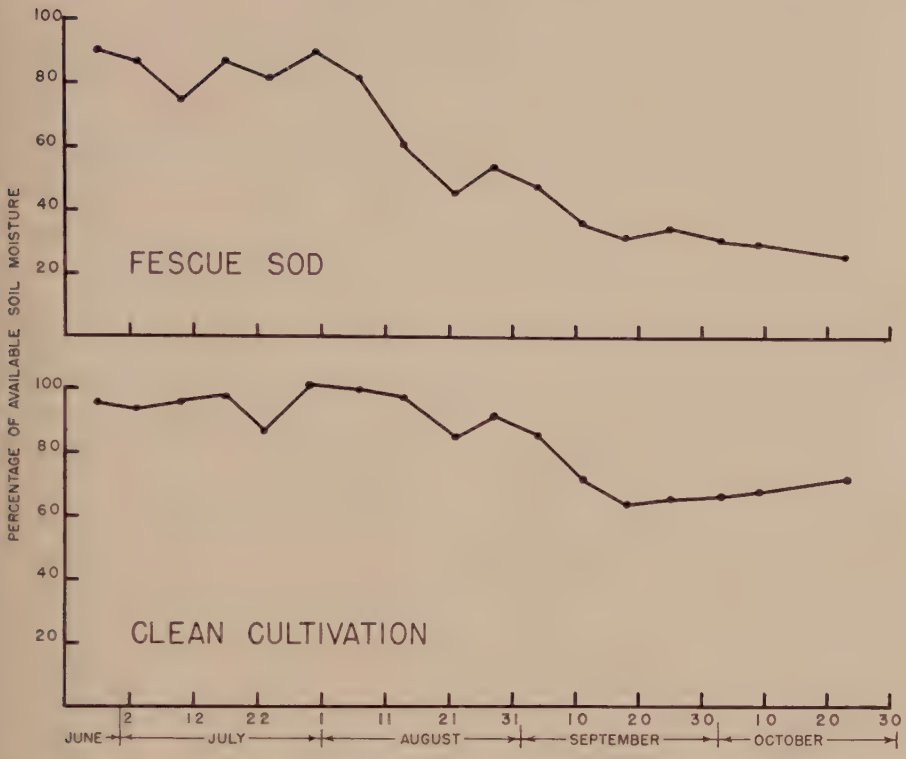

Fig. 2. Available soil moisture as influenced by 2-year-old fescue sod and clean cultivation for 2 years.

DISCUSSION

These observations indicate that sod covers, when first established, may deplete soil moisture more than clean cultivation. However, as the sod culture and clean cultivation programs are continued, more soil moisture may be found under the sod than in soil clean cultivated. This reversal of relationships apparently results from the gradual depletion of the soil and loss of structure. The sod cover still uses a considerable amount of soil moisture, but has maintained or improved the soil in regard to rainfall penetration and moisture-holding capacity. Clean cultivation, when first established, eliminates any depletion of soil moisture by crop growth. However, continued clean cultivation may reduce rainfall penetration, increase runoff and reduce moisture-holding capacity of the soil. In these orchards, runoff was noticeable in the plot cultivated for 25 years, but was negligible on the other

plots. Penetration was apparently reduced by long-term cultivation, since the rains occurring after August 21 failed to have a marked influence upon soil moisture.

According to Lewis, Work and Aldrich (1934) and Kenworthy (1949), tree growth and production may be reduced when more than 60 percent of the available soil moisture has been depleted. Moisture was below this critical level under the 2-year-old fescue sod after September 1, but never reached the critical level in soil clean cultivated for 2 years. The 25-year-old sod did not deplete moisture to the critical point until October 1, while moisture was below the critical point after August 10 in soil that had been cultivated for 25 years. This difference in the rate of depletion of available moisture would have a significant influence upon tree growth and production.

The depletion of soil moisture by sod growth has resulted in the general use of mulches with a sod cover. Mulching has been reported by Kenworthy and Gilligan (1949) to result in improved apple tree

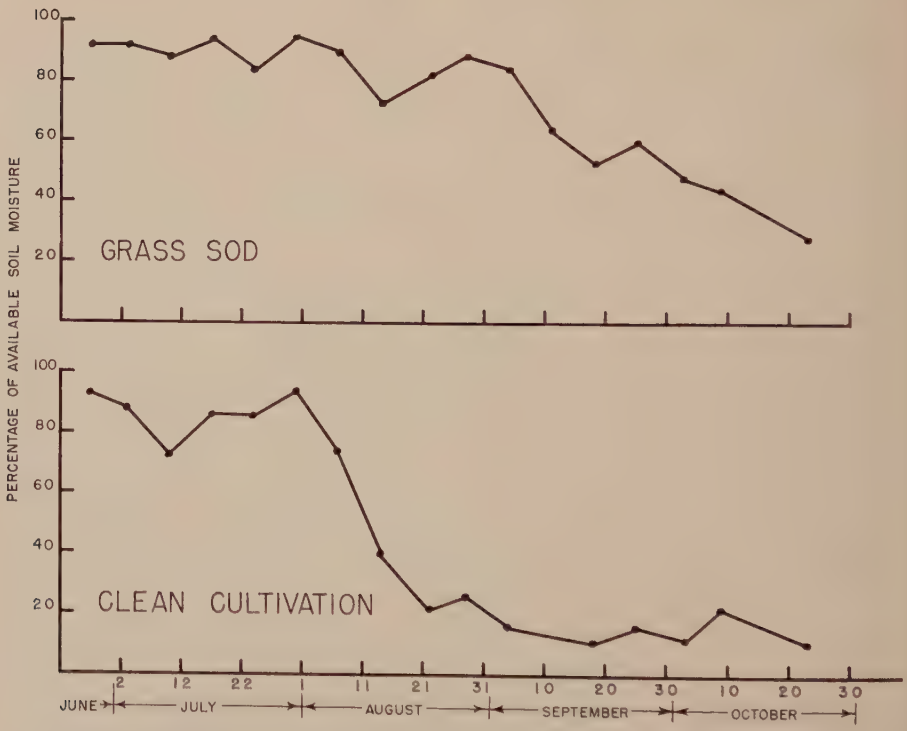

Fig. 3. Available soil moisture as influenced by a 25-year-old blue grass sod and clean cultivation for 25 years.

growth the first season. Research in progress at the Graham Substation indicates a similar response to mulching of peach trees. The mulch appears to eliminate the competition between tree and sod for soil moisture, and, in this way, prevents prolonged reduction in growth and production of the trees.

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MORE DURABLE PLASTER OF PARIS SOIL MOISTURE BLOCKS PERFECTED

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THIS IS TO ANNOUNCE that more durable plaster of paris blocks for measuring soil moisture electrically, have been perfected. The original plaster of paris blocks[1, 2, 3, 4] rapidly disintegrated under very wet soil conditions and there was need for more durable blocks. This has been accomplished by treating the blocks with plastic resins. The performance of these treated blocks, such as rate and amount of water absorption, electrical conductivity, and sensitivity to soil moisture changes, has remained unchanged by the plastic resin treatment. The type of soil moisture curve obtained is the same with both the treated and untreated blocks.

Drastic durability tests in the laboratory showed that the untreated blocks lost 90 percent of their original weight by dissolution and disintegration in water, whereas the resin-treated blocks lost less than 2 percent under the same conditions.

Treating the plaster of paris blocks with plastic resins corrects a serious weakness which has confronted their use under very wet soil conditions; they disintegrate in one or two years. A complete report concerning the plastic resin treatment is forthcoming.

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[1]Bouyoucos, G. J., and H. A. Mick (1946). Improvements in the plaster of paris absorption block electrical resistance method for measuring soil moisture under field conditions. Soil Sci. 63: 455-465.

[2]Bouyoucos, G. J. (1949). Nylon electrical resistance unit for continuous measurement of soil moisture in the field. Soil Sci. 67: 319-330.

[3]——————— (1950). A practical soil moisture meter as a scientific guide to irrigation practices. Agron. Jour. 42: 104-107.

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CAN WASHER SELECTION FOR THE DAIRY PLANT

By CARL W. HALL
DEPARTMENT OF AGRICULTURAL ENGINEERING

THERE IS A DEFINITE relationship between the size of can washer and the rate at which milk cans can be dumped. Also, the rate at which cans can be dumped is limited or controlled by the conveyor design and weigh can selection. In spite of the fact that the conventional 14-CPM (cans per minute) washer costs nearly twice as much as a 6-CPM washer and occupies three times as much area, many dairy plant operators have invested in a large-sized can washer when one of a smaller size would have been sufficient.

RESULTS

STRAIGHT-AWAY CAN WASHER

The maximum rate of dumping 10-gallon milk cans, where the design of the conveyor and the weigh can[1] are not limiting factors, is shown in Tables 1 and 2. Table 1 concerns plants which weigh manually, and Table 2 is for those which weigh with the aid of a print-weight device.

TABLE 1—Rate of dumping (cans per minute), for manual weighing and either vacuum or hand sampling

Workers in receiving room	Average number of cans dumped per minute for producer of			
	2.5 cans	5.0 cans	7.5 cans	10.0 cans
No.	*CPM*	*CPM*	*CPM*	*CPM*
1	5.2	7.1	7.6	8.2
2	8.7	9.7	10.0	10.3
3	8.9	10.0	10.5	10.9

[1]Hall, Carl W. (1953). Weigh can selection for the dairy plant. Mich. Agr. Expt. Sta. Quart. Bul. 35: 310-316.

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TABLE 2—Rate of dumping (cans per minute), with the aid of print-weigh device on scales and either vacuum or hand sampling

Workers in receiving room	Average number of cans dumped per minute for producer of			
	2.5 cans	5.0 cans	7.5 cans	10.0 cans
No.	*CPM*	*CPM*	*CPM*	*CPM*
1	6.6	7.9	8.4	8.8
2	8.7	9.7	10.0	10.3
3	8.9	10.0	10.5	10.9

The one-man operation is much more efficient than the two- or three-man operations for receiving. With properly selected and arranged equipment, one man can easily handle 80,000 pounds of milk daily. There is justification for a multiple-manned receiving room to speed up the receiving operation to assure continuous operation of the processing which follows the receiving of the milk.

It is necessary to select a can washer having an operating capacity larger than the dumping rate of the worker. The can washer must have a capacity larger than the dumping rates shown in Tables 1 and 2. This is necessary because, in the one-man operation, no cans are fed into the washer while the milk is being sampled, weighed and recorded. Even in the two- or three-man operations, the can washer is not used to full capacity. The sizes of can washer required to permit the can dumper to attain the desirable dumping rates are shown in Table 3.

TABLE 3—Dumping rates obtainable with different sizes of straight-away can washers in cans per minute, manual operation with five cans per producer

Can washer size	One-man operation	Two-man operation	Three-man operation
CPM	*CPM*	*CPM*	*CPM*
6	5.5*	5.6	5.8
8	6.1	7.3	7.7
10	7.1	8.9	9.5
12	7.1	9.7	10.3
14	7.1	9.7	10.3

*The calculated value based on time study data is 5.0 CPM. However, one operator obtained 5.5 CPM by moving a can into the washer with an extra movement of his arm, by pushing the can into the washer in the interval between the time when he sampled the milk and when he recorded the weight of the milk.

From these data it is evident that the 10-CPM washer will suffice for a typical one-man operation in Michigan, where 5 or fewer cans are received from a producer. On this basis, a 12-CPM washer or larger would not be justified. A 6-CPM washer would be too slow to utilize fully the working ability of one man. This is verified by noting from Table 1 that one man can manually dump, weigh, and record 7.1 CPM from a 5-can producer. In a one-man operation, as noted in Table 3, a 6-CPM washer permits a dumping rate of 5.5 CPM, an 8-CPM washer permits a dumping rate of 6.1 CPM, and a 10-CPM washer permits a dumping rate of 7.1 CPM. Therefore, a 10-CPM washer should be selected so that the dumping is not delayed. By the same analysis, a 12-CPM washer would be recommended for a two- or three-man operation.

The efficiency of the can washing operation can be improved by placing steam valves within easy reach of the operator (Fig. 1). The

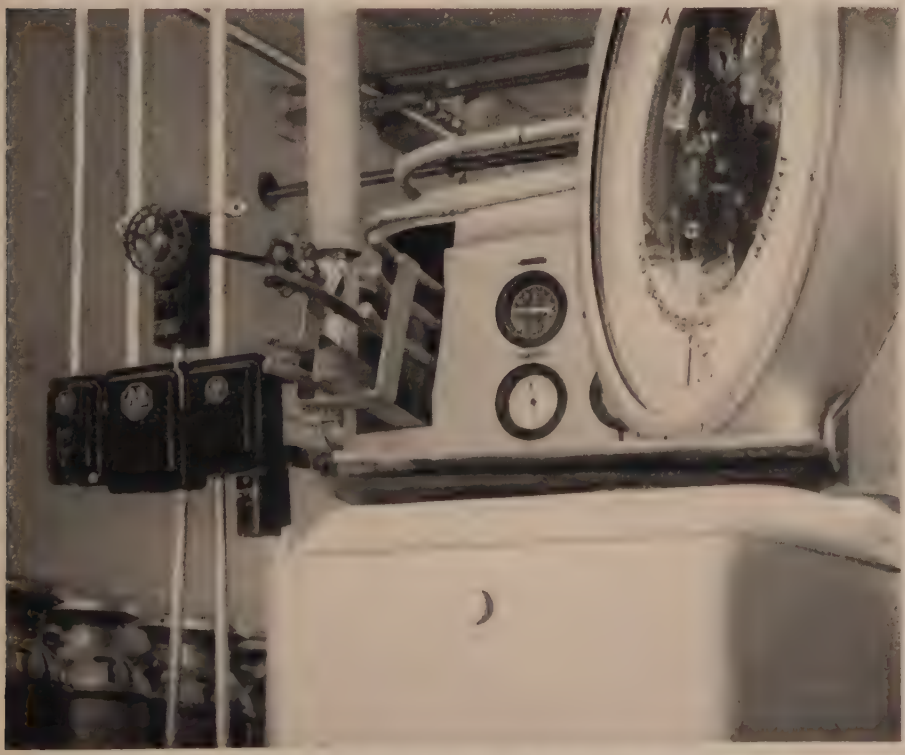

Fig. 1. The extension from the steam valve is within easy reach of operator. Switches and gages are properly placed. Can lid rack should be extended.

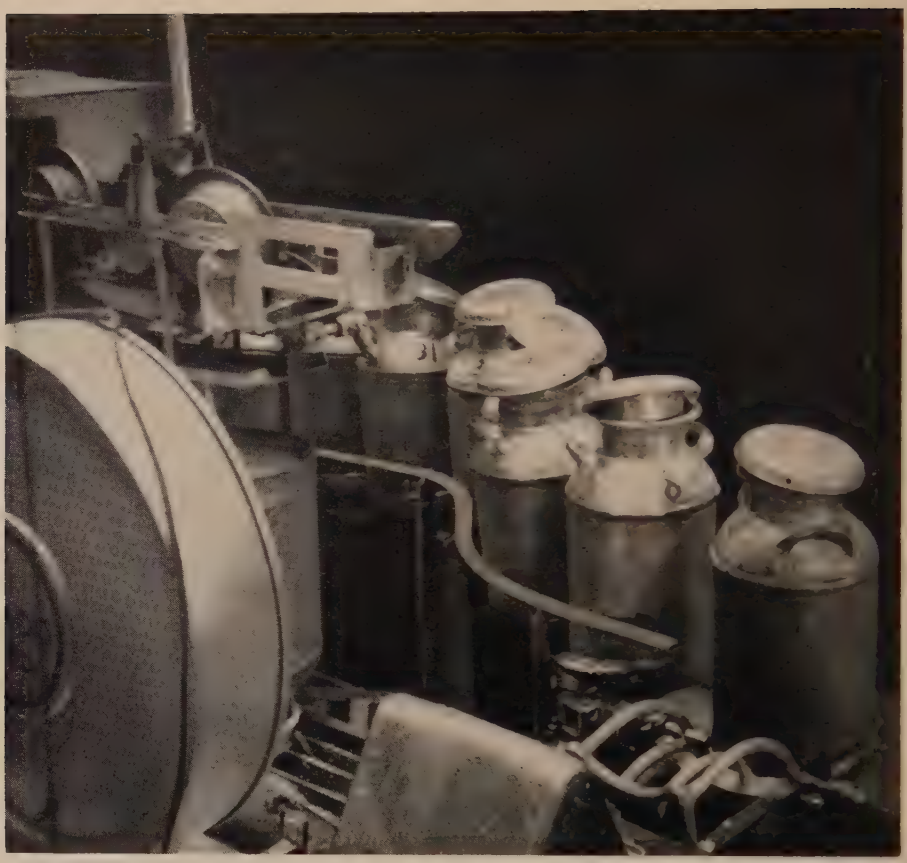

Fig. 2. A can lid extension from a conventional straight-away milk can washer which obviates the necessity for excessive reaching by the operator.

major cause of delay at the can washer is caused by lids jamming and catching inside the washer and not feeding through properly. The plant superintendent should check the can washer regularly to make sure the lids are feeding through properly, and the safety devices are functioning. The lid rack should be extended from the can washer so that the person dumping the milk can reach it without changing his position (Fig. 2).

Milk waste can be reduced by using a drip pan between the weigh can and washer to collect most of the milk which adheres to the can when it is dumped. The total economical time to be allowed for draining the cans is about 0.4 minute.[2] Thus, for a 10-CPM washer where 0.1 minute is required per can move, draining space for four cans would be required. For a 12-CPM washer, where 0.08 minute is

[2]V. Schwarzkopf (1951). Reducing milk wastes in dairy plants. Milk Dealer, Nov. 1951, p. 52.

required per man move, draining space for five cans would be required.

ROTARY CAN WASHER

The rotary can washer is recommended for small plants and is built with a capacity of from 3 to 6 CPM. The rotary can washer does not permit as efficient utilization of labor as does the straight-away washer, but its original cost is only about 60 percent as much as the same size of straight-away unit. In order to insure efficiency, a minimum of two men are required in the receiving room to use a rotary can washer while receiving milk continuously.

A time study analysis showed that one man can conveniently handle 5.85 CPM into and out of the rotary can washer. Usually, it is necessary to carry away the cans manually from the washer; if so, a 3-CPM unit will often suffice. To determine the optimum size of rotary can washer, it would be necessary to know the distance which the operator must carry the cans. Each 10 feet of walking requires 0.12 minute. If an operator must walk 20 feet with two cans, which requires 0.24 minute, the correct size of rotary can washer would be calculated as follows:

1) Time to carry two cans to dock and return—0.24 minute.

2) Time to place two cans into and remove two cans from the washer at the rate of 5.85 CPM = 0.171 minute per can, or 2 x 0.171 minute for two cans—0.342 minute.

3) Total time required to handle two cans—0.582 minute. Total time required to handle one can—0.291 minute.

4) Operator's working speed is 0.291 minute per can or $\frac{1}{0.291}$ = 3.45 CPM washer required.

An analysis of the economic factors in the use of rotary and straight-away can washers, based on 1952 prices, shows that a rotary washer should be recommended for plants having a capacity of 10,000 pounds or less per day. This is attributed to the high labor costs of today in comparison with those of 15 years ago when the rotary can washer was recommended for plants of 20,000 pounds or less per day.

SUMMARY

Initial investments and plant space requirements can be reduced in many dairy plants by using a smaller straight-away can washer. By reference to the tables included in this article, the proper size of can washer can be selected on the basis of the number of men working in a receiving room and the auxiliary equipment such as print-weight devices and vacuum samplers. A 10-CPM washer is the proper size for a typical one-man receiving room in Michigan where an average of 5 or fewer cans are received daily from one producer. Controls and gages should be placed where they can be easily seen and operated. A drip pan placed between the weigh can and can washer should be long enough to provide 0.4 minute for draining the 10-gallon cans. The rotary washer is more economical than the straight-away washer for plants receiving up to 10,000 pounds of milk daily.

THE RELATIONSHIP BETWEEN APPLE TREE VIGOR AND NAPHTHALENEACETIC ACID THINNING SPRAYS

By C. A. LANGER
DEPARTMENT OF HORTICULTURE

THE SAME APPLE VARIETIES respond very differently to naphthaleneacetic acid (NAA) thinning sprays even though treated identically. Heinicke[1], working with several varities of apples of varying degrees of vigor, concluded that a certain degree of vigor was necessary for the storage of sufficient nutrients to bring about a good set of fruit. Southwick and Weeks[2] measured dormant flower buds of the Wealthy variety in March. They found that the larger buds set more fruits than the smaller ones. Batjer[3] and Murneek[4] observed that blossoms on weak wood and small buds were thinned more easily than were blossoms on vigorous wood.

The material presented in this paper is an attempt to correlate fruit spur size with the thinning effects of various concentrations of NAA. The work was done in four commercial orchards during the seasons of 1949 and 1950.

MATERIALS AND METHODS

During the year 1949 the work was carried on in two commerical apple orchards, designated for the purpose of this experiment as Orchard I, located on the College Farm near East Lansing, and Orchard II, in the Traverse City area. In 1950 two other commercial orchards were used, being designated Orchard III, located near Fremont, and Orchard IV near Rochester. Trees of the Jonathan, McIntosh, Northern Spy, Wagener, and Wealthy varieties were included in the trials.

[1]Heinicke, A. J. (1917). Factors influencing the abscission of flowers and partially developed fruits of the apple (*Pyrus malus*). N. Y. Cornell Agr. Expt. Sta. Bul. 393. 114 pp.
[2]Southwick, F. W. and Weeks, W. D. (1949). Chemical thinning of apples at blossom time and up to four weeks from petal fall. Amer. Soc. Hort. Sci. Proc. 53: 143-147.
[3]Batjer, L. P. (1951). Fruit thinning with chemical sprays. U. S. Dept. Agr. Cir. Bul. 867.
[4]Murneek, A. E. (1951). Chemical thinning of apples. Mo. Agr. Expt. Sta. Bul. 553.

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Naphthaleneacetic acid was used as the thinning agent at the concentrations of 10, 20, and 40 p. p. m. as indicated in Table 1. The chemical was applied from a knapsack sprayer to individual spurs in sufficient quantity to wet the foliage.

Three trees of each variety were divided into three segments, one segment for a check, and one each for the two different concentrations tested. The segments were alternated so that the check would be in each of the three divisions. This plan is shown in graphic form in Fig. 1.

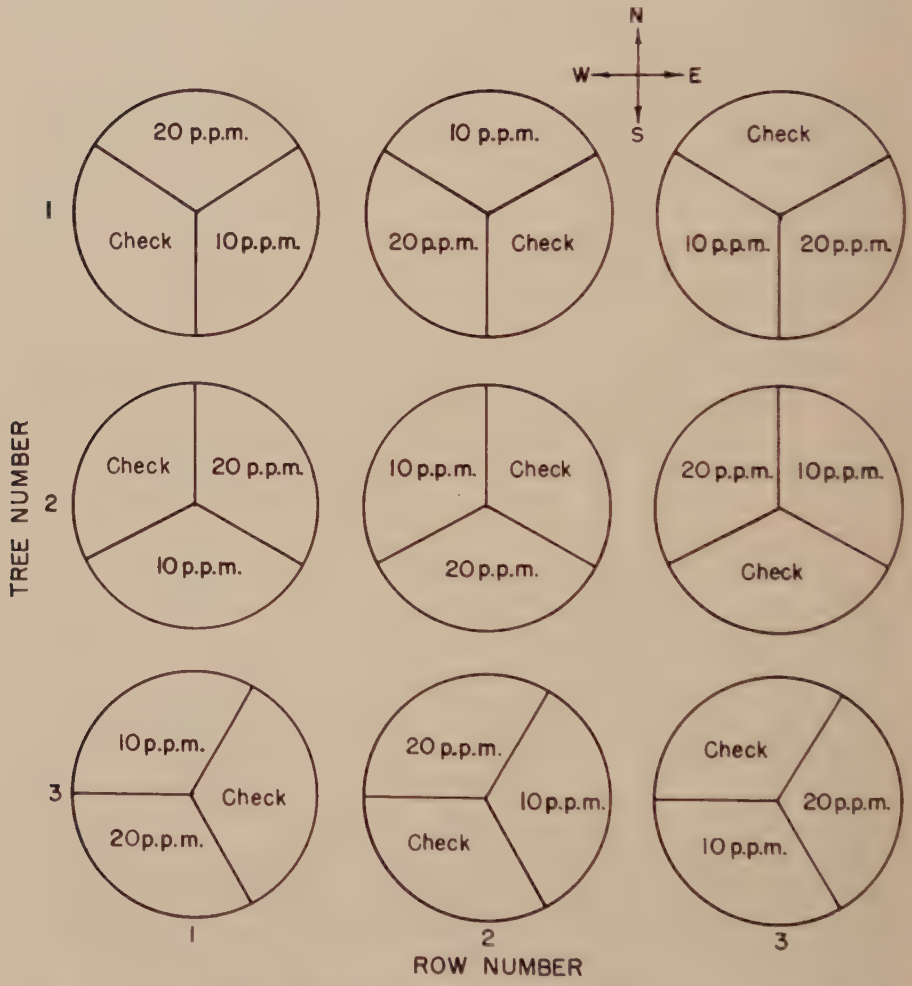

Fig. 1. Plot layout of segment treatments for testing of blossom-thinning sprays in relation to size of blossom spurs. Naphthaleneacetic acid was applied at calyx time at the concentrations indicated.

TABLE 1—Thinning effect of napthaleneacetic acid sprays in relation to size of spurs of McIntosh, Wealthy, Wagener, Jonathan and Northern Spy apples during late bloom in several areas in Michigan

No. of spurs	*Size of spurs (mm.)	Spray concentration (p. p. m.)	No. of spurs to set fruit	Set, in percent	Conditions of blossoms at time of spraying
		McIntosh—Orchard I, 1949			
31	2	Check	2	6.45	
31	3	Check	13	41.93	
32	4	Check	17	53.12	Full bloom, only few center blossoms dropping petals; temperatures above 70°F. during the daylight hours for 48 hours prior to spraying; one night frost in low areas.
32	2	10	0	6.45	
33	3	10	6	18.18	
33	4	10	12	36.36	
36	2	20	0	0.00	
34	3	20	3	9.00	
36	4	20	9	25.00	
		Wealthy—Orchard II, 1949			
34	2	Check	3	9.00	
35	3	Check	11	31.43	
34	4	Check	25	73.53	Late bloom 95 percent petals off; temperatures 70°F. or above during the daylight hours for 3 days prior to spraying; temperatures 40-50°F. for 48 hours following sprays.
31	2	20	0	0.00	
32	3	20	8	25.00	
36	4	20	16	44.44	
32	2	40	0	0.00	
35	3	40	7	20.00	
34	4	40	14	41.18	
		Wealthy—Orchard III, 1950			
36	2	Check	14	38.88	
36	3	Check	28	77.77	Late bloom, 85 percent petals off; temperatures above 70°F. during the daylight hours for 72 hours prior to spraying; 60 percent center blossoms already fertilized.
36	4	Check	35	94.44	
36	2	20	7	19.44	
36	3	20	7	19.44	
36	4	20	14	38.88	
36	2	40	0	0.00	
36	3	40	3	5.55	
36	4	40	3	8.34	

*Diameters of the previous year's growth.

(*Continued on page 270*)

TABLE 1—Continued

No. of spurs	*Size of spurs (mm.)	Spray concentration (p. p. m.)	No. of spurs to set fruit	Set, in percent	Conditions of blossoms at time of spraying
		Wagener—Orchard III, 1950			
36	2	Check	5	14.00	
36	3	Check	16	44.44	
36	4	Check	32	88.88	Late bloom, 95 percent petals off and 65 percent of center blossoms fertilized; temperatures 70°F. during daylight hours for 72 hours prior to spraying.
36	2	20	1	2.80	
36	3	20	5	14.00	
36	4	20	10	28.00	
36	2	40	0	0.00	
36	3	40	2	5.55	
36	4	40	7	19.44	
		Jonathan—Orchard IV, 1950			
36	2	Check	7	19.44	
36	3	Check	13	36.11	
36	4	Check	12	33.34	Late bloom, 50 percent of center blossoms fertilized; 75 percent of petals off; temperatures 70°F. or above during daylight hours of the blossom period.
36	2	10	0	0.00	
36	3	10	6	16.67	
36	4	10	6	16.67	
36	2	20	0	0.00	
36	3	20	0	0.00	
36	4	20	0	0.00	
		Northern Spy—Orchard IV, 1950			
36	2	Check	4	11.10	
36	3	Check	7	19.44	
36	4	Check	16	44.44	Full bloom, 25 percent of center blossoms fertilized; temperatures above 75°F. during the daylight hours for 2 days prior to spraying.
36	2	10	2	5.55	
36	3	10	5	14.00	
36	4	10	12	33.67	
36	2	20	0	0.00	
36	3	20	0	0.00	
36	4	20	0	0.00	

Orchard I —Ingham County.
Orchard II —Grand Traverse County.
Orchard III—Newaygo County.
Orchard IV—Oakland County.

Twelve fruit spurs of 2 mm., 3mm., and 4 mm. diameter each were selected at random, with care being taken to secure good distribution from top to bottom of the tree. Each spur was measured with a caliper to 0.1 millimeter at a point just below the cluster base. Each measured

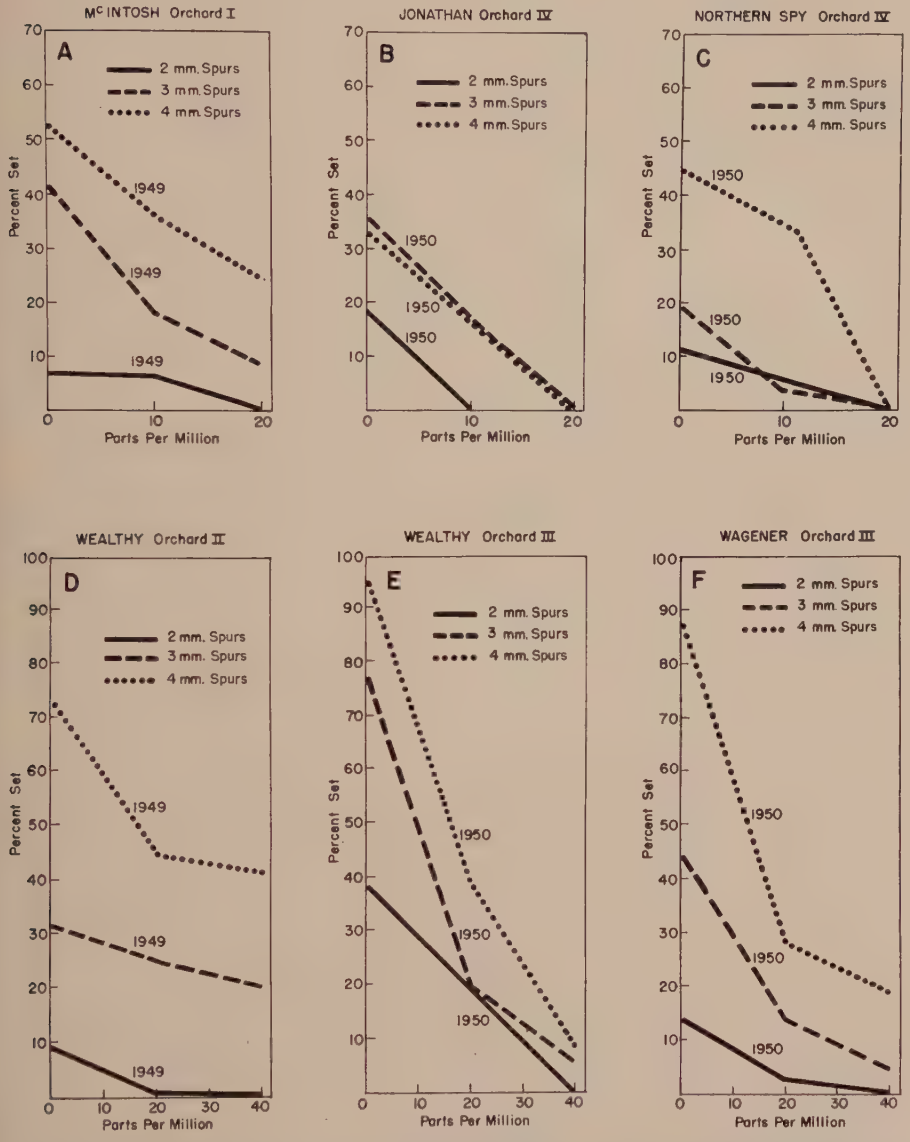

Fig. 2. Thinning effect of several concentrations of naphthaleneacetic acid on several sizes of fruit spurs of the following varieties of apples: A—McIntosh, B—Jonathan, C—Northern Spy, D—Wealthy, E—Wealthy, and Wagener.

spur was tagged and a record kept of abscission and general performance.

PRESENTATION OF DATA AND DISCUSSION

Data gathered during the years 1949 and 1950 are presented in Table 1. Regardless of variety, year, stage of floral development, and weather conditions, blossoms on spurs 2 mm. in diameter were consistently thinned the most, and those on spurs 4 mm. in diameter were thinned the least. The location of the blossoms on the tree made no apparent difference in the ease in which they were thinned.

The effect of invigorating pruning on fruit thinning is reflected in the Wealthy variety in Orchards II and III. Orchard II was heavily pruned in 1947, and Orchard III received only very light pruning. In Orchard II the trees were open and vigorous, while in Orchard III they were relatively thick, with fruit spurs generally smaller. Trees heavily pruned produce larger, more vigorous spurs than trees left unpruned or very lightly pruned. Orchard III blossoms, therefore, were thinned with greater ease than those of Orchard II (Figs. 2D and 2E).

The question whether the age of a tree is a factor in thinning depends upon the criteria that are used for age, that is, chronological age or physiological age. Generally speaking, older trees—those 20 years or more old—are thinned more readily than are younger trees. Since the results shown in Table 1 are based on the size of spur, which is a measure of vigor, the data are really comparisons of physiological age.

There is a difference among varieties, as seen in Table 1 and Figs. 2A, B, C, D, E, and F. Blossom applications of NAA at 10 p. p. m. eliminated nearly all fruits from the 2 mm. spurs of McIntosh, Jonathan, and Northern Spy varieties, and reduced the set between 25 and 95 percent on 3 mm. and 4 mm. spurs of these varieties. Applications at 20 p. p. m. thinned these same varieties excessively (Figs. 2A, B and C). On the other hand, applications of NAA at 20 p. p. m. to blossoms of the Wealthy and Wagener varieties resulted in thinning of most of the 2 mm. spurs, and reduced the set of 3 mm. and 4 mm. spurs as much as 50 percent (Figs. 2D, E and F).

During the 1949 and 1950 seasons, 20 p. p. m. of NAA was a suitable concentration for thinning of Wealthy and Wagener varieties in Orchards II and III. It is of some interest to point out that when the concentration of 40 p. p. m. of NAA was used on Wealthy blossoms in

the vigorous orchard (Orchard II) (Fig. 2D), it did not overthin as it did in Orchard III (Fig. 2E) the following year. In Orchard IV, with the Jonathan variety, application of 20 p. p. m. of NAA completely eliminated fruit on all sprayed spurs, and similar results were obtained with the Northern Spy variety in the same orchard (Table 1 and Figs. 2B and F). The severe thinning effects with Jonathan may be traced to poor conditions for pollination. Apples having only one or two fertilized seeds are thinned more readily than are those having five or six fertilized seeds. However, in the case of Northern Spy, the ease of thinning undoubtedly is due to a varietal tendency, which has been observed many times under commercial thinning procedures.

CONCLUSIONS

There is a direct relationship between spur size and the degree of thinning. When NAA is employed as a thinning spray at full bloom or at calyx time, blossoms on large spurs (4 mm. in diameter) are thinned with greater difficulty than are blossoms on smaller spurs (2 to 3 mm. in diameter).

Orchard practices which tend to increase the general vigor of the fruiting wood also decrease the thinning effect of a given concentration of NAA.

There seemingly is not a definite correlation between ease of thinning of one variety as compared with that of another even though the spur sizes and tree vigor are the same.

It was observed that pollination and fertilization of the flower parts also had some relationship to effectiveness of thinning sprays.

FURTHER OBSERVATIONS ON "CHEMICAL" BARK PEELING OF ASPEN

By A. J. PANSHIN, H. J. RAPHAEL and M. W. DAY
DEPARTMENTS OF FOREST PRODUCTS AND FORESTRY

IN THE SPRING of 1951 a number of plots were established in Michigan to evaluate the effectiveness of 2,4-D and 2,4,5-T formulations on loosening bark of aspen. These plots are located at the Dunbar Forest Experiment Station, Sault Ste. Marie, and also on properties controlled by the Patten Logging Company, Amasa, the Wm. Bonifas Lumber Company in Menominee County, and the American Box Board Company near Filer City. The results of the 1951 field tests were summarized at the conclusion of the 1951 growing season.[1] On the basis of information obtained in the 1951 trials, further experiments were suggested for the 1952 growing season. The purpose of this report is to present additional data for the 1951 season, and to describe the scope and results of the 1952 experiments.

1951 EXPERIMENTS

In the spring and summer of 1951, 10 or more aspen trees were treated on each plot at about 15-day intervals, commencing in early April and continuing through the middle of July. The chemicals used were alkanolamine (amine) salt and the isopropyl ester of 2,4-dichlorophenoxyacetic acid (2,4-D) and the propylene glycol butyl ether ester of 2,4,5-trichlorophenoxyacetic acid (2,4,5-T). On plots of two of the cooperators, the Bonifas Lumber Company and the American Box Board Company, only water solutions were applied, while on the other two plots the solutions were prepared with diesel oil. In all instances only 8-pound a. h. g. (acid equivalent per 100 gallons of solution) concentration was used.

At the time of the final inspection in the fall of 1951 the cooperators using water solutions reported negative results, and these plots were excluded from further consideration. Of the three formulations used

[1]Day, M. W., Hamner, C. L., and A. J. Panshin (1952). Preliminary observations on the effect of 2,4-D and 2,4,5-T on aspen. Mich. Agr. Expt. Sta. Quart. Bul. 34: 266-274.

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in diesel oil, 2,4,5-T ester was found to be the most effective, followed by 2,4-D ester. The amine salt of 2,4-D gave inconsistent results. No readily observable loosening of bark on the trees killed by any of these chemicals was evident at the time of the final inspection in September 1951.

1952 RE-EXAMINATION OF THE 1951 EXPERIMENTS

The plots set up at the Dunbar Forest Experiment Station and at the Patten Logging Co., Amasa, were re-examined in early June of 1952. Table 1 presents a comparison of results based on observations made in June 1952 with those made on the same trees in the fall of 1951.

The data confirm the conclusion reached in the fall of 1951—that stem spraying, with the chemicals used, was more effective than either girdling or frill-girdling followed by spraying.

The examination in 1952 of 2,4-D-amine-treated aspen indicated that this chemical was not sufficiently effective, in the concentration used, for the practical purposes for which these experiments were designed.

A considerable increase in the number of dead aspen on the plots treated with 2,4-D ester was found. Further trials in the 1952 growing season should provide additional information on the relative effectiveness of this chemical.

Stem spraying with 2,4,5-T ester resulted in 97.5 percent aspen dead at the time a check was made in June 1952. These results are considered sufficiently promising to warrant further trials with this and related formulations.

Field observations in June 1952 indicated further that the bark on all trees killed with 2,4,5-T was quite loose (Fig. 1). Some trees were felled in June and cut into standard 100-inch pulpwood, the entire lot totalling approximately three standard cords. This pulpwood was shipped to the research department of the Kimberly Clark Corporation for barking and pulping tests. A report received from the company indicates that the wood barked easily and satisfactorily. Brown discoloration to a depth up to one inch, as well as some borer damage and mold, was observed. The dark brown discoloration resulted in about a 3-point decrease in brightness, when compared with peeled, chemically untreated aspen. This decrease in brightness was not considered excessive; such wood can be handled in any mill having standard bleaching facilities. It was felt, however, that for production

TABLE 1—1951 Treatment

	2, 4-D Amine salt								2, 4-D Ester								2, 4, 5-T Ester			
	Fall 1951				Summer 1952				Fall 1951				Summer 1952				Fall 1951		Summer 1952	
	Dunbar		Patten		Dunbar		Patten		Dunbar		Patten		Dunbar		Patten		Dunbar		Dunbar	
	Dead	Alive	Dead	Alive	Dead	Alive	Dead	Alive	Dead	Alive	Dead	Alive	Dead	Alive	Dead	Alive	Dead	Alive	Dead	Alive
Percent stem-sprayed trees	2.5	97.5	6.0	94.0	15.0	85.0	44.0	56.0	56.0	44.0	25.0	75.0	78.0	22.0	81.5	18.5	82.0	18.0	97.5	2.5
Percent frill-girdled and sprayed trees	.....	100	.....	.....	3.5	96.5	.....	.....	9.5	80.5	.....	.....	30.0	70.0	.....	.....	12	88	34.0	66.0
Percent girdled and sprayed trees	.....	.....	8	92	.....	.....	66.5	33.5	.....	.....	4	96	.....	.....	80.5	19.5	.....	.....	.....	.....

Fig. 1. Condition of bark in May 1952 on aspen stem which was sprayed with 2,4,5-T in May 1951.

of high grade pulp the chemically treated wood, probably, should be used the winter following treatment.

1952 EXPERIMENTS[2]

Five to ten trees were treated at each application, at intervals of about 15 days, from the middle of May through the middle of August 1952.

The following chemicals, applied as a stem spray in diesel oil, were used: 2,4-D ester, 2,4,5-T ester, and a mixture of 50 percent of 2,4-D ester and 50 percent 2,4,5-T ester.[3] All solutions were applied in 8 pounds a. h. g. (acid equivalent per 100 gallons of solution) concentration unless otherwise noted, at a rate of about 1 gallon of solution per 10 stems. The results of these trials, as recorded in September 1952, are presented in Table 2.

In addition, a 25-percent water solution of sodium monochloroacetate was used by three of the cooperators. This chemical was

[2]The authors wish to express their appreciation to the following individuals and the companies they represent for performing this work and for collecting the data at their own expense: M. T. Kataja, American Box Board Company; M. L. Strengberg, Patten Logging Company; and L. M. Argetsinger, William Bonifas Lumber Co.

The chemicals used in these experiments were furnished by the Dow Chemical Company.

[3]The 2,4-D ester used was propylene glycol butyl ether ester of 2,4-dichlorophenoxyacetic acid, and the 2,4,5-T ester was the propylene glycol butyl ether ester of 2,4,5-trichlorophenoxyacetic acid.

TABLE 2—1952 Treatment

(Trees dead, injured and healthy, as reported in September 1952)

Month treated	American Box Board				Bonifas Lumber Co.				Dunbar				Patten Logging Co.				Average all plots		
	Number of trees			Percent dead	Number of trees			Percent dead	Number of trees			Percent dead	Number of trees			Percent dead	Percent dead	Percent injured	Percent healthy
	D*	I*	H*		D	I	H		D	I	H		D	I	H				
2, 4-D Ester, stem spray																			
May	10	0	0	100	10	0	0	100	..	..	..	...	..	..	..	...	100	0	0
June	17	3	0	85	10	0	0	100	9	0	0	100	6	7	6	32	72.5	17.5	10
July	5	15	0	25	5	0	5	50	12	12	3	44	3	6	1	33	37	49	14
August	..	..	..	...	1	1	7	11	1	6	3	10	3	4	3	33	17	38	45
September	..	..	..	...	0	0	10	0	..	..	..	...	..	..	..	...	0	0	100
2, 4-D Ester 50% and 2, 4, 5-T Ester 50%, stem spray																			
May	10	0	0	100	10	0	0	100	..	..	..	...	..	..	..	...	100	0	0
June	17	2	0	89	10	0	0	100	..	..	..	...	17	2	1	85	90	8	2
July	16	4	0	80	7	0	3	70	..	..	..	...	9	1	0	90	80	12.5	7.5
August	..	..	..	...	6	2	2	60	..	..	..	...	3	4	3	30	45	30	25
September	..	..	..	...	0	0	10	0	..	..	..	...	..	..	..	...	0	0	100
2, 4, 5-T Ester, stem spray																			
June—SS†	..	..	..	...	..	..	..	...	21	1	0	95	..	..	..	...	...	...	...
June—DS‡	..	..	..	...	..	..	..	...	10	0	0	100	..	..	..	...	...	...	...
July—SS	..	..	..	...	..	..	..	...	23	5	1	79	..	..	..	...	...	...	...
July—DS	..	..	..	...	..	..	..	...	25	5	0	83	..	..	..	...	...	...	...
July—TS§	..	..	..	...	..	..	..	...	10	0	0	100	..	..	..	...	...	...	...
August—SS	..	..	..	...	..	..	..	...	0	9	1	0	..	..	..	...	...	...	...

*D—dead. I injured. H healthy. † Single strength. ‡ Double strength. § Triple strength.

applied as a spray in three different ways: as a trunk spray, and to frill girdles and to peeled girdles. The results, based on a September 1952 check, are recorded in Table 3.

FIELD OBSERVATIONS AT DUNBAR DURING THE 1952 SEASON

Periodic checks were made during the summer months on the condition of trees treated during the 1952 growing season.

An examination made 15 days after the treatment of aspen with sodium monochloroacetate in frill girdles revealed that all trees showed definite signs of injury. This was indicated by a browning of leaves and bark in the vicinity of the frills. All trees treated with 2,4-D ester and 2,4,5-T ester and sodium monochloroacetate, sprayed on unpeeled stems and peeled girdles, exhibited no visible signs of injury.

A further check made 23 days after treatment indicated that all trees treated with sodium monochloroacetate in frill girdles, during the months of June and July, were completely defoliated. The 2,4,5-T-treated trees showed signs of injury, as indicated by leaf discoloration and characteristic orange and brown spots on the bark. There was no visible evidence of injury on aspen treated with 2,4-D ester.

Thirty days after treatment, the bark and cambial zone on trees treated with sodium monochloroacetate in frill girdles appeared almost completely dead for a distance of about 5 feet above each frill, with only a few isolated patches of green bark still in evidence. All trees were almost entirely defoliated. Unlike sodium monochloroacetate, 2,4,5-T ester appears to kill phloem and cambium in patches. Orange and brown spots on the bark, which were observed previously, became larger, some turning a brilliant orange in color. Evidence of injury, similar to that produced by 2,4,5-T ester, was observed for the first time on trees treated with 2,4-D ester.

Observations made 51 days after treatment of aspen with 2,4,5-T and 2,4-D revealed the presence of numerous orange blotches on the tree trunks. Exudations of resinous liquid from these areas were noticed, especially on 2,4-D-treated trees.

First evidence of injury, indicated by browning of leaves on peeled-girdle aspen, treated with sodium monochloroacetate, was observed 55 days after the treatment. On the same day it was noticed that on frilled aspen treated with sodium monochloroacetate the bark began to strip off easily in the areas near the frill.

TABLE 3—Sodium monochloroacetate treatment, 1952

(Trees dead, injured and healthy as reported in September 1952)

Month Treated	Girdled												Girdled and scored									Frilled								
	American Box Board			Dunbar			Patten			Average of 3 plots, percent			American Box Board			Patten			Average of 2 plots, percent			American Box Board			Dunbar			Average of 2 plots, percent		
	No. of trees			No. trees			No. trees						No. of trees			No. trees						No. of trees			No. trees					
	D*	I*	H*	D	I	H	D	I	H	D	I	H	D	I	H	D	I	H	D	I	H	D	I	H	D	I	H	D	I	H
May	3	0	2	...	...	...	...	...	...	60	40	0	5	0	0	...	...	...	100	0	0	0	2	3	...	...	...	...	40	60
June	5	5	0	2	3	5	0	16	4	17.5	60	22.5	10	0	0	0	10	0	50	50	0	5	5	0	9	0	0	74	26	0
July	10	0	0	12	7	0	6	4	0	72	28	0	10	0	0	0	7	3	50	35	15	10	0	0	15	4	0	86	14	0
August	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	7	3	0	70	30	0	...	...	...	10	0	0	100	0	0

*D—dead. I—injured. H—healthy.

A still later check, made 71 days after treatment, revealed that bark on the frilled trees treated with sodium monochloroacetate separated easily to a height of at least 7 feet above the ground. Bark on aspen treated with 2,4-D and 2,4,5-T esters was dead all around the tree for about 2 feet above the ground, but still contained green areas above that point.

A final recheck in October indicated that bark on aspen treated with 2,4,5-T in June was loose enough for satisfactory peeling and that wood beneath it showed very little discoloration. The same was true of frilled aspen treated with the sodium monochloroacetate.

RESULTS OF 1952 EXPERIMENTS

The following general observations can be offered on the basis of periodic checks made at the Dunbar Forest Experiment Station in the summer of 1952 and on the final inspection of all the plots in September of that year.

Sodium monochloroacetate is more effective when applied to frills than when sprayed on peeled or scored girdles. This chemical acts considerably faster than does either 2,4-D or 2,4,5-T. The leaves turn brown in 2 to 3 weeks after treatment, and in about 2 months the bark begins to peel in long vertical strips, extending in some cases to the top of the tree.

The 2,4,5-T ester acts more slowly than sodium monochloroacetate but faster than 2,4-D ester. In the case of both esters, leaves on the affected trees turn at first a brilliant red or yellow; this is followed by dark brown coloration. Bark injury is first evidenced by small brown or orange spots, which gradually grow larger and coalesce. A resinous exudation from the affected areas of bark accompanies this color transformation. Double and triple strength solutions of 2,4,5-T ester produce faster kill than single strength.

A mixture of 50 percent 2,4-D ester and 50 percent 2,4,5-T ester, used in 8 pounds a. h. g. concentration in diesel oil, appears to be almost equally as effective as 100 percent 2,4,5-T diluted to the same concentration.

Definite loosening of bark to a height of at least 7 feet above the frill was evident in the case of sodium monochloroacetate 71 days after the treatment. Aspen stem-sprayed in June with 2,4,5-T was in good peeling condition in October. In both cases the wood showed little or no discoloration at the time of the final inspection in October.

THE EFFECT OF CROP SEQUENCE AND EARLY SUMMER TEMPERATURE ON THE RESPONSE OF SUGAR BEETS TO SUPPLEMENTAL NITROGEN

By J. R. GUTTAY and R. L. COOK
Department of Soil Science

Frequent reference has been made to the role played by legumes in adding nitrogen to the soil. Davis and Turk (1944) found that the roots and tops of sweet clover and alfalfa plowed under on May 6 contained quantities of nitrogen ranging from 92 to 133 pounds per acre. One should then expect that the crops which immediately follow such legumes would be well supplied with nitrogen.

The writers have observed that, rather generally, sugar beets grown immediately after alfalfa have good color and are high in content of soluble nitrogen. One would not expect such beets to respond to applications of nitrogen fertilizer. Experiments at the Ferden Farm in Saginaw County have shown this to be true. These same experiments have shown that in crop rotations where sugar beets do not follow legumes, supplemental nitrogen applied as a side dressing may increase yields significantly during some seasons but not during others. The data reported in this paper show how the response of sugar beets to supplemental nitrogen may be affected by crop sequence, and an explanation is offered for the variation in degree of response from year to year.

EXPERIMENTAL PLAN

The Ferden farm is located 4 miles south of Chesaning in Saginaw County. The soil is well drained Brookston clay loam, with a pH of 6.5. The rainfall and temperature are recorded daily at a weather station on the farm.

The rotations studied since 1940 are:

1. Alfalfa-brome, alfalfa-brome, corn, sugar beets, barley
2. Alfalfa-brome, alfalfa-brome, sugar beets, corn, barley
3. Alfalfa-brome, alfalfa-brome, beans, sugar beets, barley

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4. Alfalfa-brome, corn, sugar beets, barley, oats
5. Clover-timothy, corn, sugar beets,[1] barley, oats (changed in 1952 to alfalfa-brome, alfalfa-brome (plowed down), sugar beets, corn, barley)
6. Beans, wheat, corn, sugar beets, barley
7. Beans, wheat (g. m.[2]), corn, sugar beets, barley (g. m.).

The rotations are so arranged that each replicate of each rotation has five plots, so that every crop of the rotation appears each year. The plots are in a split-plot experimental design, with four replications. Manure has been applied at a rate of 10 tons per acre on rotations 1, 2 and 3 (where 2 years of hay were removed) and at 7 tons per acre on rotations 4 and 5 (one year hay removed). Each plot is further divided into sub-plots, and from 1940 to 1950 one side received 1,000 pounds per acre of 2-16-8 fertilizer during each five years, and the other side received 400 pounds per acre. In both cases, one-half of the fertilizer was applied to sugar beets. A change in the fertilizer plans was made in 1951. Since that time the plots which had received 2-16-8 at the rate of 400 pounds in 5 years have received 4-16-8 at the rate of 2,000 pounds. Those which had received 1,000 pounds per acre of 2-16-8 before 1951 were continued at the same rate, but the fertilizer analysis was changed to 4-16-8. These sub-plots were further divided into sub-sub-plots, one of which was sidedressed with 40 pounds of nitrogen. A more complete description of the plots is available in a publication by Robertson, Cook, Rood and Turk (1952).

EXPERIMENTAL RESULTS AND DISCUSSION

The sugar beet yields obtained during the four years when the sub-sub-plots were sidedressed with nitrogen are given in Table 1. The yields shown in the columns labeled "check" are from those plots not receiving nitrogen sidedressing. The columns labeled "increase from nitrogen" show the yield increases of the nitrogen sidedressed plots over those not sidedressed. The decreases in yields, shown as blanks in the table, were not significant.

Two important differences are apparent in the data. One pertains to "rotation effects" and the other to "seasonal effects." The beets in rotation 2 behaved differently than did those in all the other rotations. In no instance did the nitrogen sidedressing cause a significant increase in yield in this rotation where the beets followed alfalfa. This was

[1] In 1951 the sugar beets followed immediately after the clover-timothy.
[2] A green manure mixture of sweet, June, alsike, and mammoth clovers.

TABLE 1—Effect of nitrogen sidedressing, rotations and fertility level on the yields of sugar beets at the Ferden Farm for four different years

Rotation†	Fertility level‡	Tons per acre								Total response to N.§
		1948		1949		1951		1952		
		Check	Increase from N.	Check	Increase from N.	Check	Increase from N.	Check	Increase from N.	
1	H	12.3	1.8*	9.0	.....	13.6	1.7*	12.2	.....	7.0
	L	10.7	1.8*	6.5	.....	12.9	1.7*	12.0	.....	
2	H	8.9	.....	8.3	0.2	14.3	.....	11.9	0.4	0.7
	L	7.8	0.1	6.2	.....	14.7	.....	12.0	.....	
3	H	12.3	1.6*	10.1	.....	15.4	0.2	13.9	.....	4.2
	L	10.7	2.3*	6.8	.....	14.6	0.1	11.7	.....	
4	H	11.7	1.9*	8.7	.....	11.1	3.4*	12.7	0.9	7.0
	L	10.7	0.3	5.7	.....	12.7	0.3	13.1	0.2	
5	H	11.5	2.2*	10.1	.....	8.5	2.0*	11.0	0.2	8.6
	L	10.5	1.3*	7.1	0.4	8.3	2.5*	11.3	.....	
6	H	10.7	2.1*	8.8	0.3	9.0	3.3*	11.9	0.6	12.5
	L	9.0	1.7*	5.5	2.0*	9.4	1.5*	11.3	1.0	
7	H	11.6	0.9*	8.8	1.8*	9.6	3.8*	13.1	0.5	11.6
	L	9.5	0.9*	6.2	0.2	10.8	2.5*	12.8	1.0	

*Statistically significant increases due to nitrogen sidedressing; other increases are within experimental error.

†Rotations are listed on page 2.

‡"H" refers to high fertilization of 1,000 pounds of 2-16-8 per acre for each 5 years of rotation, and "L" refers to low fertilization of 400 pounds of 2-16-8 per acre for each 5 years for the 1948-1949 data. For 1951-1952 "H" refers to 2,000 pounds of 4-16-8 per acre for each 5 years, and "L" refers to 1,000 pounds of 4-16-8 per acre for each 5 years.

§Obtained by adding the increase in yield for the four years at both fertility levels.

true despite the fact that total yields in the plots were lower during two of the years than on the plots in the other rotations. That occurred during the relatively wet seasons of 1948 and 1949. Smith and Cook (1946) suggest that low yields of beets following alfalfa may occur during wet years and this may be due to the intermediate products of alfalfa decomposition.

Rotation 3 falls in a class by itself. Response to nitrogen occurred during one of the four years. In this rotation, beans followed alfalfa-brome and beets followed the beans. The data from two complete

rotations (10 years) show this sequence of crops to be the most favorable of the seven under trial, so far as sugar beet production is concerned. Perhaps one of the reasons is that beans draw less heavily than does corn on the nitrogen supplied by the decomposing alfalfa. Thus, more is left for the following beet crop.

Rotations 6 and 7, where beets followed corn, may be grouped together so far as response to nitrogen is concerned. In the case of rotation 6, there was no legume in the rotation. The data show that the greatest response to nitrogen fertilizer occurred in this rotation but that beets in rotation 7 responded only slightly less. In this latter rotation the legume was mixed green manure plowed under for corn and for beans. The results are summarized in the last column of Table 1.

Rotations 1, 4 and 5 fall into a second group. In these three rotations beets followed corn which, in turn, followed a legume-grass hay crop. In this group the greatest response to nitrogen occurred in rotation 5 where the total increase for the four years (both fertility levels) was 8.6 tons, the third highest response in the field. In this rotation the legume was red clover and the grass timothy. Following next were rotations 4 and 1 where the total response was 7.0 tons in each case. Here the beets followed an alfalfa-brome mixture which had been cut for hay one year, in the case of rotation 4, and two years in rotation 1. From the data it is evident that nitrogen response was more consistent in rotation 1 than in 4. About half of the total increase in yield in rotation 4 was due to the increase in yield obtained on the high-fertility sub-plots in 1951. On the other hand the increases in rotation 4 were about equal for the two years 1948 and 1951. Thus one might assume the data from rotation 1 to be more reliable.

The data presented in Table 1 show that the over-all response to nitrogen varies from year to year. Yet, there is a similarity in response between the years 1948 and 1951 and between the years 1949 and 1952. In examining the weather data for those years (Table 2), one notes the most striking differences to have occurred in June and July. During those months in 1948 the weather was cool and wet, and sugar beets showed the greatest response to nitrogen sidedressing. In 1951 it was cool but drier than in 1948, and the sugar beets showed slightly less response. It was warm and wet in 1949, and significant response occurred only in rotations 6 and 7. In 1952, the weather was warm and dry, and there was no significant increase in yield of beets from nitrogen sidedressing.

TABLE 2—The mean temperature and total rainfall of June and July at the Ferden Farm

	1948	1949	1951	1952
Mean temperature, °F.	67	73	67	72
Total rainfall, inches	7.8	11.3	4.2	4.7

This differential seasonal response of sugar beets to nitrogen sidedressing is probably due to the effect of temperature on the activity of nitrifying organisms. It has been shown by Waksman (1932) that at 95° F. there may be twice as much nitrification in the soil as at 86° F. If this was true in these experiments, then it can be assumed that there was more nitrate formation during the warm seasons of 1949 and 1952—hence, less response to fertilizer nitrogen. By plotting the total number of days during June and July when the temperature was over 86° F., as given in Table 3, against the percentage of the plots

TABLE 3—Number of days in June and July that had an extreme temperature over 86°F. at the Ferden Farm

	1948	1949	1951	1952
June	4	15	2	15
July	9	15	12	22
Total	13	30	14	37

where beets responded significantly to nitrogen sidedressing, as given in Table 1, the curve shown in Fig. 1 was obtained. The curve indicates a correlation which was found to be significant ($r = 0.989$), according to the method of analysis set forth by Snedecer (1946). (The "r" value at the 1-percent level is 0.990).

From this it appears that extremes in daily temperatures had a marked effect on nitrification in the soil, perhaps a greater effect than what might be expected from 5 or 6 degrees difference in mean temperature. The data indicate that rainfall had very little effect on nitrate formation. This agrees with the thoughts expressed by Waksman who

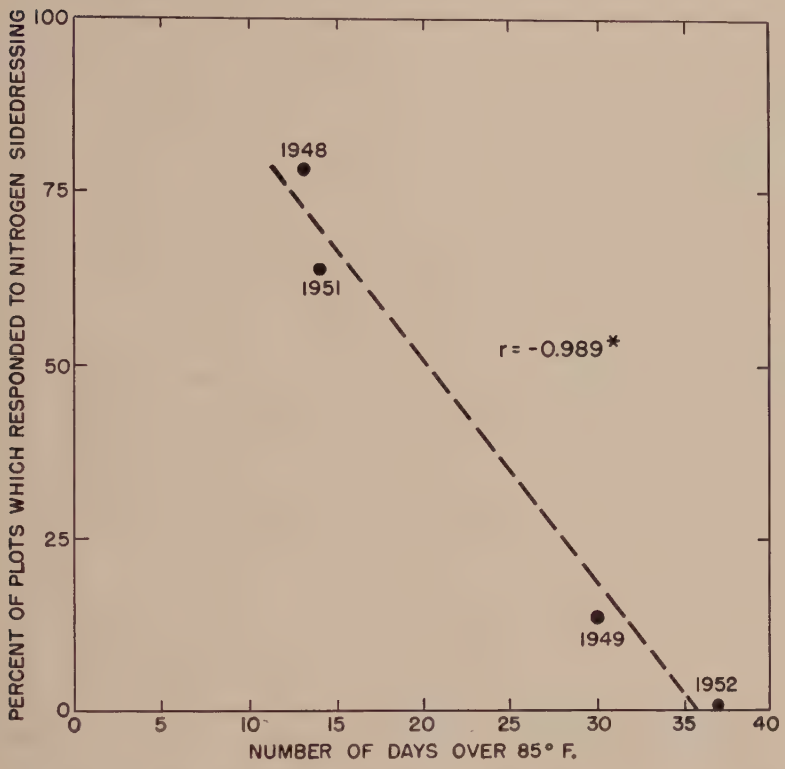

Fig. 1. The percentage response of sugar beet plots to nitrogen sidedressing, as compared with the extreme temperatures of June and July.

***Significant at the 5-percent level.**

"r" value for test of significance at the 5-percent level = 0.950, 1% = 0.990.

showed that nitrification is reduced in the soil only after a very high moisture content is reached.

SUMMARY AND CONCLUSIONS

Sugar beets were grown in seven rotations, variable with respect to the kind of legume and the sequence of crops. During the years 1948, 1949, 1951 and 1952, nitrogen was applied at the rate of 40 pounds per acre to one-half of each plot. Where sugar beets followed directly after alfalfa-brome, the nitrogen did not cause increases in yield. During only one year was there an increase caused by the nitrogen where the beets followed beans which had in turn followed alfalfa-brome.

The greatest response to nitrogen occurred where beets followed corn in a non-legume rotation, but almost as much increase in yield resulted from its use in the rotation where the legume was mixed green manure turned under twice during the five years.

Medium response occurred where beets followed corn which had followed June clover or alfalfa-brome.

Response was variable from year to year. Temperature records showed that significant increases in yield resulted from nitrogen applications during cold seasons and did not generally occur during warm seasons. A significant negative correlation was found between the percentages of plots where significant response occurred and the number of days when the temperature rose above 86° F.

These data seem to warrant the conclusion that sugar beets should receive supplemental nitrogen where they follow corn but not where they follow alfalfa and that the practice may be profitable where the preceding crop was beans. In the latter instance the application would probably be advisable if alfalfa did not precede the beans.

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COMPARATIVE ANALYSIS OF HYDROGRAPHS FROM SIMILAR STORMS ON A WATERSHED UNDER TIMBERED AND CLEAR-CUT CONDITIONS[1]

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FORESTERS, hydrologists, and others have long been interested in the effect of land cover on runoff and soil erosion, as illustrated by a comparison of hydrologic records from the same watershed under different cover conditions. However, such records are not generally available from timbered watersheds. A recent change in management practices of the wooded watershed of the Michigan Hydrologic Research Station[4] provided one year of little or no cover-conditions which may be satisfactorily compared with previous timbered conditions.

This watershed is one of three hydrologic installations in the East Lansing area utilized to study the effects of freezing and thawing of soils upon various hydrologic phenomena within watershed areas having different land-use practices. The other two watersheds are cultivated under good rotations. After hydrologic conditions under a well-stocked oak-hickory stand were studied for 11 years, the wooded watershed was commercially clear-cut for saw-logs and cordwood in the winter of 1951-52. This was done in order to determine the effect of clear-cutting upon the hydrology of this type of watershed. A young growth of oak, hickory, and cherry was left on the area for natural reforestation.

The Lansing area has an average annual precipitation of 31.43 inches and a growing season of 158 days. Killing frosts may be expected from October 10 to May 5. The annual precipitation during the frost-free period averages 20 inches. The climate of the area is classified

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[4]A cooperative project of the Michigan Agricultural Experiment Station, and the Division of Soils Research of the Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture.

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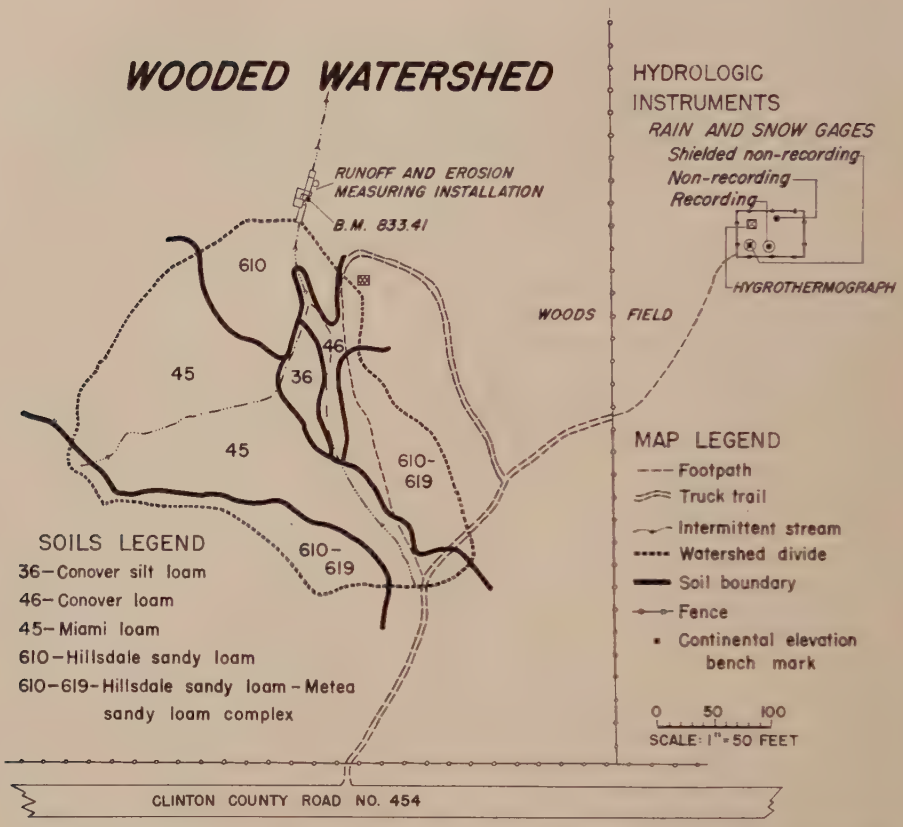

Fig. 1. Map of the wooded watershed, showing soil boundaries and hydrologic installations.

as alternating between continental and semi-marine, with changing meteorological conditions.[5]

Soils of the wooded watershed are of five types. About half of the area is classified as Miami loam, approximately three-eighths as Hillsdale sandy loam—Metea sandy loam complex, and the remainder as being equally divided between Conover silt loam and Conover loam. These are all Gray Brown Podzolic soils and, with the exception of the Metea, are unstratified. These soils are derived from glaciated parent materials of sandstone, shale and/or limestone consistency. With the exception of Conover, these soils are well drained. Subsoil textures range from sandy clay loam to clay loam for the Metea soils, sandy loam for the Hillsdale soils, and silty clay loam to clay loam for the Conover soils.

[5]Wills, Merrill H. (1941). Supplementary climatic notes for Michigan. Yearbook of Agriculture, 1941, *Climate and Man*. pp. 923-924. U. S. Dept. Agri., Washington. 1248 pp.

While under timbered cover, these soils have been remarkably successful in absorbing precipitation. During the 11-year period from 1941 to 1952, the wooded watershed lost to surface runoff only 5.96 inches from a total of 360.5 inches of precipitation. The major portion of this runoff occurred at times when the soil was in a saturated and glazed condition prior to the spring breakup.[6]

The wooded watershed has an area of 1.65 acres and a weighted average slope of 6.1 percent.

Figure 2, a crown cover map of the watershed prior to cutting, illustrates the density of cover over the forest floor. This vertical projection of the crowns of all stems one inch or more in diameter shows that only an extremely small portion of the surface of the forest floor was subjected to the direct impact of raindrops. It has been estimated that an old growth of oak-hickory forest in a 40-inch rainbelt intercepts 6 to 7 inches of rainfall annually.[7] It seems reasonable to assume that, in the Lansing area, a cover such as that which existed on the wooded watershed would have intercepted a proportionate amount. Such interception has the effect of decreasing the amount of water actually available for run-off.

A cruise of the watershed before cutting showed a total of 9,010 board feet in the 10- to 18-inch diameter class. This amounted to 4,914.5 board feet per acre. The largest volume was in black oak *(Quercus velutina)*. In the 5- to 9-inch class there were 749 cubic feet on the watershed, or 454 cubic feet per acre. The largest volume in this class was recorded in the hickories. Of the basal area of the stand, 90.3 percent was in the 5- to 19-inch class. The black oaks had the largest basal area of the stand—173 square feet, or 105 square feet per acre. Average age of the dominants in the stand was 65 years. There was a total of 2,008 stems on the watershed in the 1- to 19-inch category. Of this total, 1,685 stems were less than 5 inches in diameter. These yield figures clearly illustrate the dense overstory and understory found on the watershed prior to clear-cutting operations.

Figure 3, a crown-cover map of the watershed following the completion of the clear-cutting operation, illustrates the extent of the remaining understory. Many of the stems under 5 inches in diameter were bent and broken during the winter logging operation. Many of the others lost much of their crown. The logs were skidded out with

[6]Smith, J. L., and Crabb, G. A., Jr. (1952). Progress report on the wooded watershed of the Michigan Hydrologic Research Station. Mich. Agr. Expt. Sta. Quart. Bul. 34: 383-394.

[7]Zon, Raphael (1941). Climate and the nation's forests. Yearbook of Agriculture, 1941, *Climate and Man*. pp. 477-487. U. S. Dept. Agri., Washington. 1248 pp.

a tractor and much of the original litter on the soil surface was disturbed, exposing it to the direct action of raindrops and, also, permiting greater evaporation through the increased exposure of the surface to wind and sun. The removal of the overstory and most of the understory also resulted in more rapid snow melt,[8] which would tend to

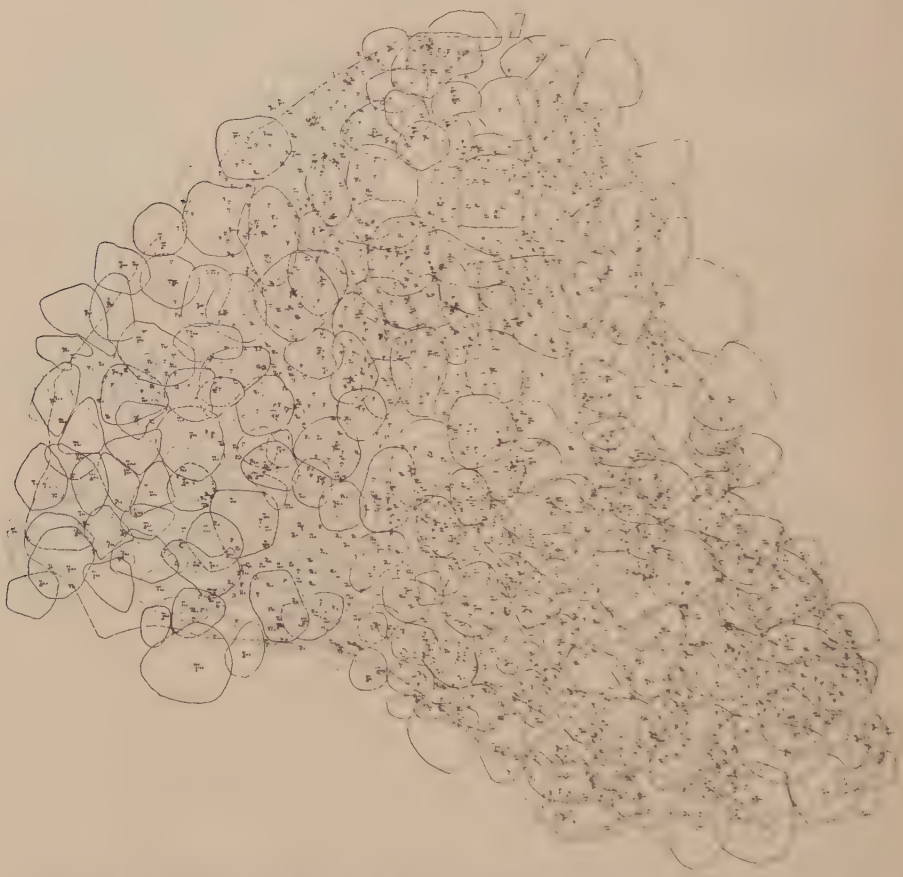

Fig. 2. Crown-cover map of the wooded watershed prior to clear-cutting operations. This map accurately locates the overstory of all vegetation on the watershed having a stem-diameter of 1-inch or more, and clearly illustrates the dense cover found on the watershed prior to the winter of 1951-52.

increase surface runoff. Such a condition allows a more rapid freezing of the surface soil,[9] contributing to runoff when precipitation falls on

[8]Craddock, George W., and Hursh, Charles R. (1949). Watersheds and how to care for them. Yearbook of Agriculture, 1949, *Trees*. pp. 603-609. U. S. Dept. of Agri., Washington. 944 pp.

[9]Zon, Raphael. *Op. cit.*

a frozen surface. The compaction of the soil by logging operations also tends to reduce its capacity to absorb water.[10]

The year 1952 provided only a few storms of sufficient duration or intensity to produce runoff from any of the watersheds at East Lansing. The wooded watershed did, however, yield surface runoff

Fig. 3. Crown-cover map of the wooded watershed following completion of clear-cutting operations in the spring of 1952. This map locates the overstory of all vegetation remaining on the watershed with a stem-diameter of 1-inch or more.

as the result of two storms in 1952. These two storms have been analyzed and compared with two similar storms occurring during the period prior to clear-cutting the watershed. It is realized that a complete analysis of hydrologic changes resulting from the cutting opera-

[10]Craddock and Hursh. *Op. cit.*

tion must necessarily cover a period of several years' record. However, it is felt that an analysis of the first year's storms is important though providing an insufficient basis for definite conclusions. If such an analysis is compared with that of similar storms, valuable information as to the probable effects of clear-cutting upon the hydrologic relationships of the watershed will result.

Of the two storms considered, it will be noted that one was of high intensity and short duration, while the other was of low intensity and long duration. In view of the fact that conditions preceding a storm determine to a large extent the disposition of infiltrated water or surface runoff, these antecedent conditions have been carefully checked and tabulated and are reflected in the analyses.

TABLE 1—Conditions prior to storms of April 10-13, 1952 and December 21-23, 1949

Date	Precipitation	Date	Precipitation
	(*Inches*)		(*Inches*)
3-25-52	0.01	12- 1-49	0.15
26	.04	2	....
27	Trace	3	.32
28	.01	4	....
29	....	5	....
30	....	6	.08
31	.01	7	.07
4- 1-52	.06	8	.02
2	....	9	....
3	.03	10	.26
4	.18	11	.11
5	.94	12	....
6	.18	13	....
7	.04	14	....
		15	....
Total	1.50	16	....
		17	....
4-10-52	.21	18	.34
11	....	19	....
12	.70		
13	.90	Total	1.35
Total	1.81	12-21-49	1.31
		22	.59
		23	.02
		Total	1.92
Preceding soil moisture: 18.8% on 3-24-52		Preceding soil moisture: 26.7%	
Air temperature range during and before this storm: 32.5° to 44.5°F.		Air temperature range during and before this storm: 6° to 53°F.	

The storm of August 16-17, 1952, was characterized by a high intensity of precipitation. Antecedent soil moisture on August 11 was determined gravimetrically to be 17.9 percent. A comparable storm occurred June 28, 1943. Soil moisture measurements were not available from the wooded watershed until after 1943, and are therefore not available for this early storm. However, precipitation for a month before each of the two storms in question is shown in Table 2. Records of antecedent precipitation do not clearly indicate the soil moisture at the time of a storm, but they do provide some basis for comparison.

ANALYSIS OF THE STORMS

At 7:46 p. m. on April 10, 1952, a low-intensity rain of 1 hour 20 minutes' duration fell on the recently clear-cut wooded watershed. This storm reached a maximum intensity of 0.24 inch per hour. Rainfall began again at 10:00 a. m. on April 12 and continued for 10 hours 21 minutes, with a maximum intensity of 0.36 inch per hour. During this period a runoff of low intensity commenced at 2:54 p. m., April 12 and continued for 4 hours 37 minutes. The runoff ceased for 51 minutes. At 11:12 p. m. on April 12 precipitation again began to fall and continued uninterrupted until 9:15 a. m., April 13. This storm recorded its highest intensity just before cessation, with a peak intensity of 0.6 inch per hour. This peak intensity is reflected in the runoff hydrograph, which showed its greatest rise during the period of 9:00 to 11:30 a. m. on April 13.

On April 13, a low-intensity rain fell from 5:00 p. m. to 7:00 p. m., and after a 30-minute lapse began again and continued until 7:32 a. m., April 14. Intensities were very low except for the first 35 minutes of this period. The runoff hydrograph shows a rise in response to this rain, beginning at 7:45 p. m., April 13.

Total rainfall for this storm was 2.13 inches, with a maximum intensity of 0.6 inch per hour for a period of 2 minutes. The total surface runoff amounted to 0.0511 inch.

The storm of December 20-22, 1949 was chosen as a comparison storm for that of April 10-14, 1952. This storm differed from the April storm in four important aspects: 1) Intensities were higher and intensity peaks were of longer duration. 2) There were longer breaks between individual rains in the April storm than in the December storm. A period of 2 days elapsed between the initial and subsequent rainfall in the April storm, while the longest break in precipitation for the

TABLE 2—Conditions prior to storms of August 16-17, 1952 and June 28, 1943

Date	Precipitation (Inches)	Date	Precipitation (Inches)
7-15-52	....	5-27-43	....
16	0.11	28	....
17	Trace	29	0.21
18	1.02	30	.39
19	....	31	.27
20	.27	6- 1-43	.59
21	....	2	2.16
22	.35	3	....
23	.13	4	....
24	....	5	....
25	....	6	.13
26	....	7	.05
27	....	8	....
28	.23	9	....
29	....	10	....
30	....	11	....
31	....	12	.08
8- 1-52	....	13	....
2	.06	14	....
3	.11	15	....
4	.71	16	.05
5	....	17	.17
6	....	18	....
7	....	19	....
8	....	20	....
9	.73	21	.03
10	....	22	....
11	Trace	23	....
12	....	24	....
13	....	25	....
14	....	26	....
15	....	27	....
Total	3.72	Total	4.13
8-16-52	1.80	6-28-43	2.17
17	.20		
Total	2.00	Total	2.17

Extended Antecedent Conditions:

Date	1952	1943
January	2.01	2.20
February	1.54	1.47
March	2.09	2.68
April	3.58	2.55
May	4.09	6.52
June	1.15	(1-27) 3.26
July	2.79	
August 1-15	2.11	
Yearly total antecedent precipitation	19.36	19.10

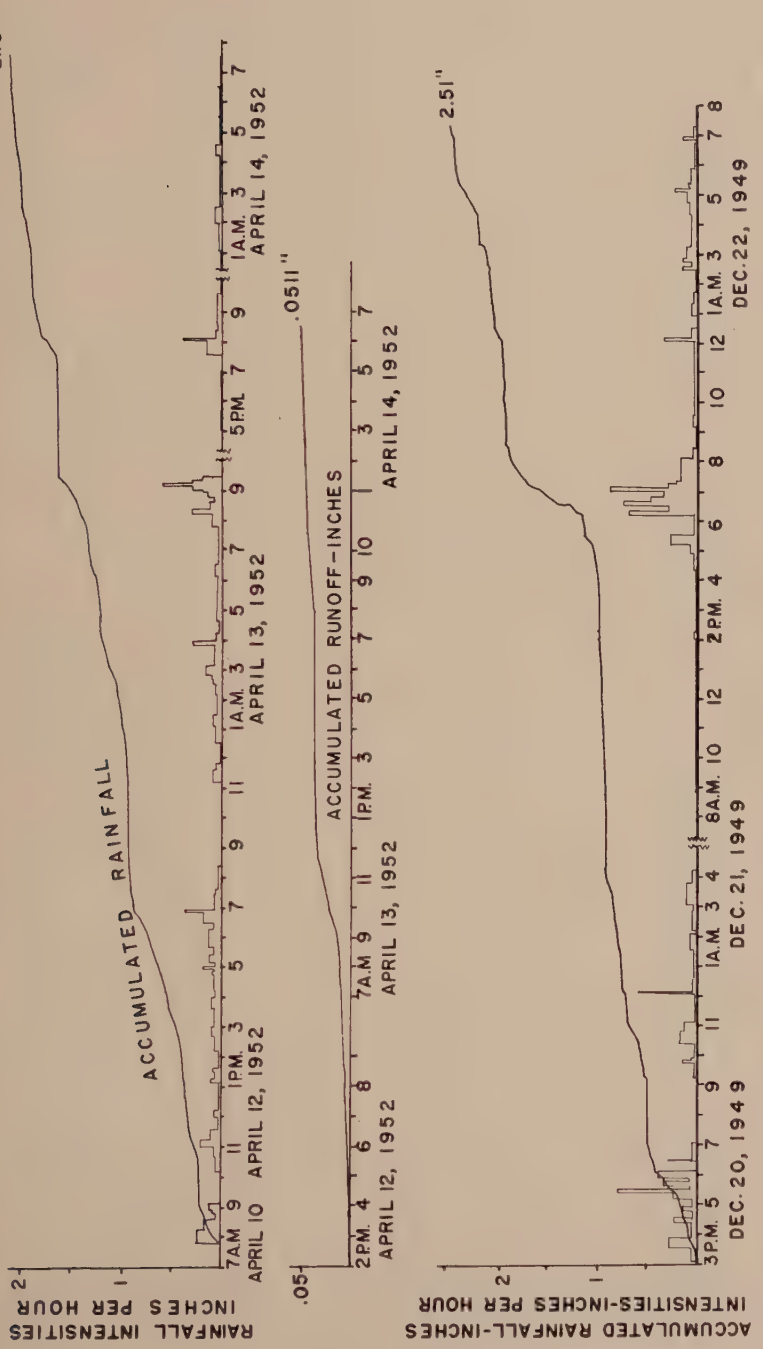
RAINFALL INTENSITIES INCHES PER HOUR
ACCUMULATED RAINFALL
2.13"
.05
.0511"
ACCUMULATED RUNOFF-INCHES
7A.M. 9 11 1P.M. 3 5 7 9 11 1A.M. 3 5 7 9 5P.M. 7 9 1A.M. 3 5 7
APRIL 10 APRIL 12, 1952 APRIL 13, 1952 APRIL 14, 1952
2P.M. 4 6 8 7A.M. 9 11 1P.M. 3 5 7 9 10 3 5 7
APRIL 12, 1952 APRIL 13, 1952 APRIL 14, 1952
ACCUMULATED RAINFALL-INCHES INTENSITIES-INCHES PER HOUR
2.51"
3P.M. 5 7 9 11 1A.M. 3 4 8A.M. 10 12 2P.M. 4 6 8 10 12 1A.M. 3 5 7 8
DEC. 20, 1949 DEC. 21, 1949 DEC. 22, 1949

Fig. 4. Comparative hydrographs, showing precipitation and surface runoff for the storms of April 12-14, 1952, and December 21-22, 1949.

December storm covered a period of only 5 hours. 3) Total rainfall for the December storm was greater. This storm produced 2.51 inches precipitation, while the April storm produced only 2.13 inches. 4) The December storm occurred during a period of lower temperatures than those recorded during the April storm. Soil temperature at 1 inch below the surface on December 20 was 30° F., dropping to 29° F. on December 21 and rising to 30° F. on December 22. Precipitation on December 20 and 21 occurred in the form of rain, with mixed rain and snow falling on the 22nd.

At 3:04 p. m., December 20, precipitation began as a 4-hour rain, with a peak intensity of 0.8 inch. This was followed by a 2-hour break in rainfall. Rainfall began again at 9:14 p. m., reaching a peak intensity of 0.6 inch at 12:03 a. m. Precipitation ceased at 4:16 a. m., December 21. At 8:48 a. m. precipitation began again at a low intensity, and continued to fall at approximately 0.01 inch per hour until 4:41 p. m. the same day, at which time intensities began rising. Between 6:00 and 8:00 p. m., peak intensities reached 0.75, 0.78 and 0.9 inch for periods of 4, 10 and 6 minutes, respectively. Precipitation continued at low intensities until 12:01 a. m., December 22, when intensities reached a peak of 0.35 inch. Rainfall ceased at 12:30 a. m., to begin again at 12:54. Intensities for the remainder of the storm were in the neighborhood of 0.10 inch to 0.24 inch per hour. This storm produced no runoff.

Soil moisture prior to this storm was 26.7 percent, and 13 days previous to the April storm it was 18.8 percent. During this 13-day period preceding the April storm 1.40 inches of precipitation occurred. During the antecedent period, part of the soil moisture would have evaporated or percolated to lower horizons. It is felt that the antecedent rainfall added to the recorded soil moisture of 18.8 percent would not have been sufficient to have raised the soil moisture above the 26.7 percent, which was recorded prior to the storm of December 20, 1949. It should also be noted that the soil absorbed 0.38 inch more precipitation from the December storm than it did during the April storm. This was accomplished without yielding surface runoff.

As previously stated, soil temperatures were nearer the freezing point during the December storm than during the April storm. These lower temperatures would be expected to have produced conditions conducive to lower infiltration rates. However, the fibrous, loose character of the upper horizon of the protected soil absorbed the higher

intensities and greater amounts of rainfall without yielding surface runoff.

The storm of August 16, 1952 fell on soil having a moisture content of approximately 17.9 percent. This storm began at 5:20 a. m., August 16, with a relatively low intensity. Peak intensities of 0.9 inch were reached on two occasions for a total of 6 minutes, before dropping to a low intensity of 0.06 inch for a period of approximately 1 hour 15 minutes. Commencing at 7:46 a. m., the intensities rose rapidly to a peak of 1.65 inches for 4 minutes, followed by one of 2.1 inches for 4 minutes, and then receded to 1.5 and 1.0 inch for periods of 2 and 6 minutes, respectively. This was followed by a rise to 1.5 inches for 2 minutes, followed by a low of 0.3 inch for 4 minutes.

Runoff began at 8:04 a. m. and recorded its highest intensity during the 31-minute initial period following 8:04 a. m. Peak intensities of 2.76, 2.40, 1.80 and 1.40 inches for periods of 5, 3, 2, and 3 minutes marked this interval. The intensities then dropped to 0.6 inch for 9 minutes, followed by a rate of 0.9 inch for 2 minutes; they then fell slowly until 9:45 a. m., at which time precipitation ended. Runoff actually ended at 10:35 a. m., but the runoff occurring during the final 75 minutes was insignificant.

At 9:36 p. m., August 17, precipitation began again with an initial intensity of 0.6 inch, rising rapidly to 2.4 inches for 1 minute, falling to 0.3 inch for 2 minutes and then rising to 1.2 inches for 1 minute. A period of low-intensity rain was then followed by a 1-minute peak of 1.8 inches, followed by an intensity of 0.8 inch for 3 minutes. This latter rain produced no runoff. The initial accumulated rainfall from this storm amounted to 1.8 inches, with that of the succeeding rain amounting to 0.2 inch.

A more detailed study of this storm would require a three-part analysis of the storm, with divisions at 7:46 a. m. and 9:45 a. m., August 16, and one for the duration of a final rain beginning at 9:20 p. m. and ending at 10:11 p. m., August 17. Such an analysis reveals that during the first portion of the storm 0.28 inch of precipitation occurred in 162 minutes, producing no runoff. During the second part 1.52 inches of precipitation occurred, marked by intensities up to 2.76 inches per hour. This portion of the storm extended for 119 minutes and produced the runoff. The third part of the storm, occurring one day later, was marked by 0.20 inch precipitation with no runoff.

The storm of June 28, 1943, began at 1.28 a. m., with an initial intensity of 2.40 inches. This was followed by a period of 112 minutes

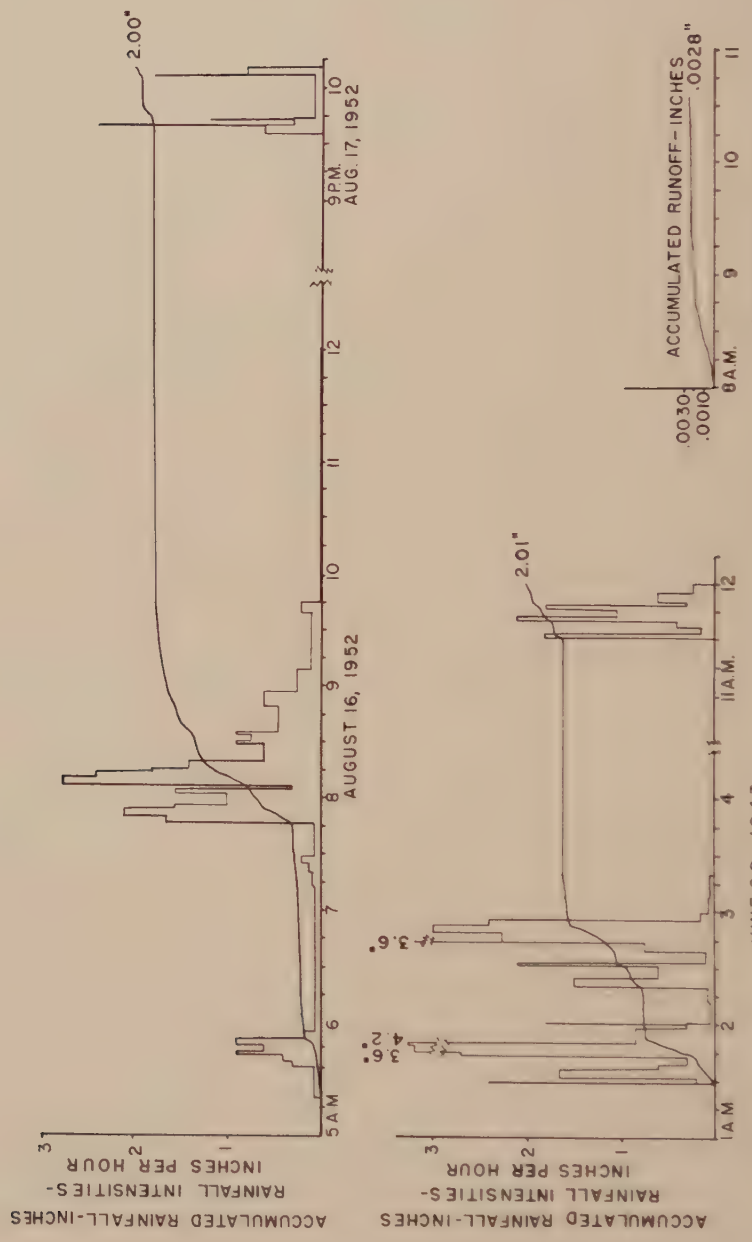

Fig. 5. Comparative hydrographs, showing precipitation and surface runoff, of the storms of August 16-17, 1952, and June 28, 1943.

of precipitation during which time the intensities fluctuated between rates of 4.2 inches per hour and 0.05 inch. After a period of 8 hours marked by no precipitation, rain again commenced and reached intensities of 1.8, 2.1, 1.05, and 1.8 inches for 2-, 2-, 4-, and 2-minute intervals, respectively.

This June storm may also be divided into two segments for analysis. During the first period, which ended at 3:20 a. m., 1.62 inches of rain fell during 112 minutes, while during the second 0.39 inch occurred in 30 minutes. There was no runoff. In comparing the two storms, if one compares only the second segment of the first storm with the first segment of the second storm, it will be noted that the first storm yielded runoff after absorbing 0.28 inches of prior precipitation followed by 1.52 inches of rain of high intensity in 119 minutes. The second storm yielded no runoff even though 1.62 inches of rain fell in 112 minutes under higher intensities. If the first two segments of the August storm are combined, it will be found that the total rainfall amounted to 1.8 inches in 265 minutes, and that runoff occurred. On the other hand, during the first segment of the June storm 1.62 inches of rainfall in 112 minutes was absorbed with no runoff.

The final precipitation, amounting to 0.38 inch, of the August storm came one day later than the other rains but had no effect on runoff. The final precipitation of the June storm occurred only 8 hours 10 minutes after the initial rain and amounted to 0.39 inch, likewise with no runoff.

It will be noted that the August storm began with low intensities which rose rapidly and after the soil had absorbed 0.28 inch of rainfall, it was in a condition to yield runoff. However, the wooded watershed has been subjected to these conditions in the past and has been able to absorb more initial rain and higher later intensities without yielding runoff.

Detailed comparison of these two storms is made more difficult by the lack of soil moisture data preceding the June 1943 storm. However, an examination of Table 2 shows that the wooded watershed was subjected to 19.10 inches precipitation from January 1, 1943 through June 27, 1943. From January 1, 1952 through August 15, 1952, the cut-over, wooded watershed was subjected to 19.36 inches precipitation.

SUMMARY

This article is of necessity a progress report. It is doubtful if the small runoffs from the two runoff-producing storms of 1952 were of enough significance to provide a basis for stating that the cutting of timber from the watershed, with its attendant effects, was responsible for the runoffs which occurred. Such proof must come from analysis of several years of rainfall-runoff hydrographs.

However, in view of the fact that 1952 was a relatively dry year, with few storms of high intensity and long duration, it is felt that these two storms are indicative of the probable results of such a comprehensive analysis. There should be more than a passing interest in noting that the clear-cut watershed yielded runoff—even if only in small amounts, as the result of storms with intensities of less than 1 inch per hour on April 13, and less than 3 inches per hour on August 16, 1952. Similar storms occurring before removal of the timber-cover produced rainfall of higher intensities, but there was a complete retention of the precipitation. Several instances in the history of the study when the intensities produced by storms of similar magnitude to the 1952 storms were in excess of 4 and 5 inches per hour but produced little or no runoff. Several of these storms occurred when the percentage of soil moisture was comparable to that which was associated with the 1952 storms.

In the light of this tentative and preliminary analysis of similar storms under different cover conditions, it is anticipated that the removal of a timbered cover will have a profound effect upon the absorption of precipitation by a watershed. Runoff will be probably occasioned by storms having smaller intensities and totals of precipitation, and erosion losses will be consequently greater.

DISEASE PROBLEMS ASSOCIATED WITH PEN-TYPE DAIRY BARNS

By A. R. DRURY
Department of Surgery and Medicine

Interest in pen-type dairy barns has caused many dairymen to wonder if, by changing from the use of the stanchion-type to the pen-type barn, they might avoid certain problems of disease and management.[1] At the outset, however, it should be stated that a pen-type barn is not the solution for all disease problems; some will be helped, but others may be magnified. The purpose of this article is to discuss some of these problems and their solutions. Included are a number of case histories of Michigan dairy herds.

MASTITIS

Mastitis is one of the most serious of dairy disease problems regardless of the type of barn in which the cows are housed. Seven out of the last ten consultations of the author with Michigan veterinarians involving herds with mastitis problems concerned herds where pen-type housing was used. Cows are creatures of habit. Milk secretion, a complex phenomenon, may often be disturbed by the slightest variation in the handling of the animals. For instance, abrupt changes in the milking operation may result in a temporary abnormality in the milk, diagnosed as clinical mastitis or garget, which is classified as non-infectious mastitis.

The following case histories concern various phases of mastitis in some herds observed by the author.

THE IMPORTANCE OF BACTERIAL STUDY

One farm, to be designated as Farm D, having a 15-cow herd housed in a stanchion-type barn, had experienced little trouble from

[1]For a discussion of the advantages and disadvantages of pen-type barns, the reader is directed to Brown, L. H., B. F. Cargill and B. R. Bookhout (1952). Pen-type dairy barns. 1st rev. ed. Mich. Agr. Expt. Sta. Sp. Bul. 363. 32 pp.

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mastitis for several years. The operator decided to raise his heifers and, thus, milk 30 cows. In order to accommodate his greatly increased herd, he decided to change to the use of a pen-type barn. He milked his cows in shifts during the summer, and by fall had changed over completely to the use of a milking parlor. Monthly direct microscopic tests showed no infection, but the strip cup frequently showed clinical evidence of mastitis, which bacteriological study revealed to be non-infectious mastitis. The only plausible explanation was that the trouble was due to the change in handling routine, because time alone has solved the problem. The case history of Farm D demonstrates the importance of proper bacterial study in handling a mastitis problem. The use of every antibiotic possible would have been ineffective in this situation and would have been a waste of money.

THE IMPORTANCE OF CLEAN HOUSING AND TRAFFIC WAYS

Another farm, identified as Farm R, presented a herd for study. During a period of 2 months previous to the author's visit, 3 cows had died from mastitis. Sixteen cows remained in this herd, and 1 of them was sick and down in the housing area. The other 15 normal-appearing cows were negative in respect to bacterial infection. The sick cow was revealed to have a coliform infection in the right rear quarter. These bacterial organisms are associated with animal wastes which are prevalent in barnyards and in the environment of dairy cattle. The organisms vary greatly in virulence, but sometimes by invading the udder they cause a severe infection. Since it is a practical impossibility to remove all organisms from the area occupied by cows, effort must be made to prevent the organisms from getting into the udder.

During his initial visit to the farm, the author noted that nearly all the cows had "mud boots," even though there had been little rain during the past month. The cause of the condition became evident when one traced a cow through the milking operation. Prior to being milked, the cows congregated in the bedded area; then they entered the barn in a single traffic lane. After being milked, they left by a second opening and walked along a passageway 5 feet wide and 40 feet long, which was unpaved, unbedded and muddy. The mud was readily picked up on the ends of the teats, and it provided a good carrier for bacteria which could later invade the udder through the teat canal. This was especially prone to occur because cows have milk moisture on the ends of their teats.

Paved or well bedded traffic areas are the solution for this common fault in pen-type barn set-ups. Dipping the ends of the teats in a bactericidal solution will control the bacterial population. Because of their lasting effect, quaternary ammonium solutions are preferred.

A third farm on which mastitis was a problem was a larger one, having some 60 milking cows. This was designated as Farm W. During the time the herd had been handled in a stanchion-type barn, only an occasional outbreak of mastitis had occurred. Then, the cows were gradually moved into a new pen-type milking parlor and, at the same time, a new milking machine of a different make was put into operation. Immediately many cows were reported to have showed flakes and garget on the strip cup. A few were said to have developed acute mastitis.

On the evening of the author's first visit, 4 cows were giving abnormal milk. During the preceding 3 days, following strip-cup evidence of abnormal milk, 12 cows had been treated. Bacteriological studies of milk samples made by the author revealed 5 cows to have streptococcic or infectious mastitis; these were treated. A month elapsed, during which time, by agreement, no animals were treated. This was done in order that a valid test of all animals would be possible. At the time of the second test, 6 cows were giving flaky milk, and 11 showed the presence of mastitis organisms; only 2 of the 11 had given positive tests the previous month. Six other cows of the 11 had an invalid status at the time of the previous test, and 3 others were new cases, of which 1 had a serious teat injury. The other 2 had eroded teats. Quarter samples were collected, after which all four quarters of each infected animal were treated. Bacteriological tests revealed 2 cows to be positive in respect to streptococci in all four quarters, 4 cows were positive in three quarters, 1 cow in two quarters, and 4 cows in one quarter. All infected quarters responded to treatment, with the exception of a total of three quarters involving 2 animals. These were given further treatment. A subsequent recheck showed that one cow did not respond and was sold.

A significant observation made of the cows on Farm W was the relationship between cows with teats having weak sphincters and the incidence of mastitis. The predominance of the infection was in animals that had teats which "leaked." In this herd, 17 cows had a marked tendency to "leaking," and 9 of these were among the 11 infected animals. This points up the necessity for extra care in handling such animals in a pen-type barn. In such a barn, the cows do not enter the

milking parlor in any particular order. Consequently, the dairyman does not always have the opportunity to milk first the cows which have already let down their milk or which may be "leaking."

MISCELLANEOUS CONDITIONS

Another problem that is magnified in some herds housed in pen-type barns is footrot. In some herds observed by the author almost all animals were infected. Again, as was true in the case of Herd R, a major fault was that of traffic patterns. In one instance the cows stood in a very soiled area prior to entering the milking parlor. The cows which were first infected then contaminated the area, exposing the others. Such grossly soiled areas should never be allowed to develop. In this herd the worst cases were given individual treatment, and in addition a box containing lime and copper sulfate was placed in the exit in such a manner that all cows were compelled to step in it. Had circumstances permitted, a more desirable location for the box would have been in the entrance. Steps were also taken to clean up the soiled area as well as to make the approach to the parlor fan-shaped with a concrete incline to prevent an extremely soiled area at the entrance.

In some pen-type barns where cows have not been dehorned much damage has been done from jostling. Introduction of new animals to others kept in close confinement is always hazardous because of the social order which exists in a herd of cows. More than likely, heifers can best join the group by being introduced to the herd soon after they become pregnant. Dry cows can be put through the parlor with little loss of time and, thus, they are seen daily and can get their grain. Cows in estrous (heat) sometimes present problems and must be temporarily confined; else, injuries may result when such animals are left with the rest of the herd in a barnyard of insufficient area.

Another problem associated with the use of pen-type barns is that of flies, especially in the spring. The life cycle of flies is 21 days from egg to adult. This illustrates the importance of more frequent cleaning of the "loafing" area during the fly season, along with the use of anti-fly sprays. Such efforts have been noticeably effective in reducing fly populations.

SUMMARY AND RECOMMENDATIONS

In summary, the following points are pertinent from the viewpoint of disease control in the planning of pen-type installations:

1) After shifting to pen-type housing, temporary changes in quantity and quality of milk are likely to result because of the radical change in the established habits of the cows. Early examinations for infectious mastitis and prompt initiation of proper therapeutic measures should prevent serious trouble.

2) Avoid soiled traffic areas by having a fan-shaped approach with good drainage so that the cows do not stand in manure while awaiting their turn to be milked. Have an ample supply of good bedding available and use it liberally. Dipping the ends of teats in a bactericidal solution as a mastitis control measure is more important in pen-type housing than in the stanchion-type stable. Avoid long passageways at entrances and exits so that soiled areas do not develop. If possible, pave the outside "loafing" area adjacent to the barn. These items are important in control of footrot and mastitis.

3) Clean the loafing area and barnyard frequently during the fly season to control the flies.

4) Dehorn all cattle. Select breeding stock that does not have a tendency toward teat patency ("leakers"). Establish a milking order to milk these animals first.

5) Be sure that the milking stalls are large enough to accommodate the breed of cattle to be handled. Persistent abscesses on the pin bones of large cows have been observed because the stalls were too short and ill-fitting.

6) Somewhere in the protected spot of the loafing area provide good substantial stocks to confine animals for blood testing, obstetrical work or medication. Oftentimes a stanchion incorporated in a gate is very satisfactory and adds little expense.

7) Provide maternity stalls in which to segregate animals approaching parturition and in which to confine estrous animals to prevent their being injured.

JOURNAL ARTICLE ABSTRACTS

The Effect of Precipitation and Temperature Upon the Radial Growth of Red Pine

Dils, Robert E., and Maurice W. Day

Am. Midland Naturalist 48: 730-734. 1952 (Journal Article 1229 from the Michigan Agricultural Experiment Station)

Foresters and ecologists have for decades attempted to determine just what influence climate has on tree growth. Two of the most frequently studied facets in climate are precipitation and temperature. A 3-year dendrometer growth study on a red pine, *Pinus resinosa* Ait., in Chippewa County, Michigan, indicated a close relationship between precipitation and radial growth. The amount of radial growth appears to be attendant upon the presence of a surplus of soil moisture, particularly during the earlier part of the growing season. Any period of 10 days to 2 weeks or more without rainfall is usually accompanied by a diminishing in the radial growth. Temperature appears to influence this growth primarily through its effect upon the length of the growing season.

A Comparison of Fertility in Panicles of *Bromus inermis* Leyss in Michigan

Knobloch, Irving W.

Phytomorphology 2: 243-245. 1952 (Journal Article 1253 from the Michigan Agricultural Experiment Station)

A sampling of 30 bromegrass panicles from the Achenbach strain grown in Michigan revealed the following variability pattern: 1) Correlation between the spikelets per panicle and florets per panicle was significant as was also that between the spikelets per panicle and seeds per panicle and between the florets per panicle and seeds per panicle. 2) Correlations among the same components when the florets and seeds were put on a spikelet basis were not significant. 3) Spikelets per panicle varied from 16 to 90, with a mean of 50.2; florets ranged from 91 to 662, with a mean of 359; seeds fluctuated from 2 to 333, with a mean of 138. 4) The seed-setting ranged from 1 to 72 percent, with a mean of 39.5. The number of seeds per spikelet ranged from 0 to 8, with a mean of 2.75, and the number of florets per spikelet ranged from 1 to 14, with a mean of 7.16.

Tetraploid Smooth Bromegrass

Knobloch, Irving William

Bul. Torrey Bot. Club 80: 131-135. 1953 (Journal Article 1282 from the Michigan Agricultural Experiment Station)

Two plants of smooth bromegrass, *Bromus inermis*, 554-39 and 554-49, are reported to be tetraploids, with a somatic complement of 28 and a meiotic set of 14 bivalents. Pairing is regular. The tetraploids flower later than do the octoploids, and their pollen grains are smaller. Actidione was used to pre-treat the chromosomes to shorten them. The possible origins and one of the functions of the tetraploid are discussed.

Studies on Histomonas meleagridis. I. Use of Antibiotics to Facilitate Isolation of Histomonas meleagridis

DELAPPE, IRVING PIERCE

Experimental Parasitology 2: 79-86. 1953 (Journal Article 1297 from the Michigan Agricultural Experiment Station)

The incorporation of penicillin and streptomycin (100 or 500 units/ml.), either singly or conjointly, in Laidlaw's medium facilitated the initial isolation of *Histomonas meleagridis* from the host and also prolonged its survival time, *in vitro*. Such cultures were not sterilized, but there was evidence of bacterial contamination.

Attempts to free stock cultures of Histomonas of their entire bacterial flora were unsuccessful; when the bacterial flora disappeared a concomitant of this disappearance was the death of the flagellate shortly thereafter.

Tyzzer's findings relevant to the deleterious effect of blastocystis on Histomonas were confirmed.

The Effects of Temperature and Photoperiod on the Development of Pea Varieties

REATH, A. N., AND S. H. WITTWER

Proc. Am. Soc. Hort. Sci. 60: 301-310. 1952 (Journal Article 1323 from the Michigan Agricultural Experiment Station)

Pea varieties, representative of important commercial types, were grown in the greenhouse at 9-, 12- and 16-hour photoperiods each at 50° and 60° F. night temperatures and in successive field plantings.

Observations as to days requisite to flowering, days to maturity, degree-days from seeding to flowering, pod characteristics and vine heights suggest that both photoperiod and temperature have a marked influence. At 60° F. night temperature, Alaska and Surprise were day-neutral with respect to flowering and pod production, but at 50° F. flowering was hastened by long days. Other varieties (Gradus, Alderman, Walah, Early Perfectah, Idaho Whites, Pride, Wando) behaved as long-day plants at both 50° and 60° F. night temperature. In all midseason and late pea varieties the number of degree-days required for flowering was reduced progressively by exposure to 12- and 16-hour photoperiods. For field plantings the multiple of degree-days summation and average length of daylight was found to be a less variable expression than the heat sum alone.

Some Effects of Preharvest Foliage Sprays of Maleic Hydrazide on the Sugar Content and Storage Losses of Sugar Beets

WITTWER, S. H., AND C. M. HANSEN

Proc. Am. Soc. Sug. Beet Tech.: 90-94. 1952 (Journal Article 1325 from the Michigan Agricultural Experiment Station)

The application of 2500 p. p. m. of maleic hydrazide as a spray to the foliage of sugar beets 3 to 6 weeks before harvest resulted in a significantly higher sucrose content in the roots without any effect on total tonnage. Thermocouple connections showed that during 30 days of storage, temperatures in the bins of sugar beets harvested from plants sprayed with maleic hydrazide were several degrees lower than in control lots. Losses of sugar during 30 days of storage were considerably reduced by a spray containing 2500 p. p. m. of the sodium salt of maleic

hydrazide applied 4 weeks before harvest. Apparently a preharvest foliage spray of maleic hydrazide not only increases the percentage of sucrose in the roots of sugar beets at harvest time, but also tends to reduce the respiratory loss of sucrose during storage.

The Effect of Spray Materials on the Quality of Canned and Frozen Montmorency Cherries

BEDFORD, C. L., AND W. F. ROBERTSON

Food Tech. 7: 142-144. 1953 (Journal Article 1326 from the Michigan Agricultural Experiment Station)

A 3-year study indicated that the spray materials, ferbam, nabam, proprietary copper, copper and Dow Wax 222, and nabam and wax do not differ significantly in their effect on the quality of canned and frozen Montmorency cherries, even though significant differences were found in the soluble solids contents of the canned cherries. Variation in the quality of processed cherries, however, does result from various cultural practices and climatic conditions during the growing season.

A Study of the Effects of Seven Systems of Cropping Upon Yields and Soil Structure

ROBERTSON, L. S.

Proc. Am. Soc. Sug. Beet Tech.: 255-264. 1952 (Journal Article 1330 from the Michigan Agricultural Experiment Station)

The rotation and crop sequence experiment, started in 1940 on Brookston clay loam soil, was used for certain physical studies, including dry screen analyses of seedbeds, aggregate analyses of root bed soils, and porosity determinations on core samples. Legumes greatly increased the yields of sugar beets and corn and markedly changed the structure of the soil. Soils prepared for corn contained more large clods where legumes had not been grown. Legume production resulted in the formation of a greater percentage of larger and more stable soil aggregates. The percentage of total and non-capillary pore space was increased by the production of legumes. Differences in soil pore space were greater at the end than at the beginning of the season. Soil crusting was found to be less on plots where legumes had been grown.

A Flame Photometric Determination of Calcium, Strontium, and Barium in a Mixture

HINSVARK, ORVILLE N., SYLVAN H. WITTWER, AND HAROLD M. SELL

Analytical Chemistry 25: 320-322. 1953 (Journal Article 1338 from the Michigan Agricultural Experiment Station)

The utilization of flame photometry provides a quick, accurate method for the determination of small quantities of calcium, strontium, and barium found in mixtures. Analysis of solutions which contain known amounts of these elements (added to perchloric acid in the form of carbonates) is possible after a graphical correction for the interference to calcium from strontium, and to barium from calcium. Regulation of the acetylene pressure to provide the proper emission intensity of a standard is necessary to provide accurate and reproducible results.

Further Studies on Vitamin E Deficiency in the Lamb

BACIGALUPO, F. A., R. CULIK, R. W. LUECKE, F. THORP, JR., AND R. L. JOHNSTON

Jour. An. Sci. 11: 609-620. 1952 (Journal Article 1346 from the Michigan Agricultural Experiment Station)

The experiment was designed to study further certain chemical and histopathological changes in the suckling lamb produced by the feeding of a diet low in vitamin E. The main symptom of vitamin E deficiency was muscular weakness which developed parallel with muscular dystrophy. Evidences of muscular defection were wobbling joints, dragging feet, mild stiffness of the legs and a peculiar, marching-like gait. Treatment with dl-γ-tocopherol acetate was again shown effective in curing and preventing vitamin E deficiency in the lamb. However, the same vitamin was not completely effective in restoring the health of lambs in an advanced stage of vitamin E deficiency. Lambs showing symptoms of vitamin E deficiency had a high urinary creatine excretion (177 to 412 mg./day) accompanied by a low level of plasma tocopherol, (0.050 to 0.081 mg./100 ml. plasma).

A Quantitative Study of Rumen Synthesis in the Bovine on Natural and Purified Rations. I. Protein, Dry Matter and Non-Protein Nitrogen

AGRAWALA, I. P., C. W. DUNCAN, AND C. F. HUFFMAN

Jour. Nutri. 49: 29-39. 1953 (Journal Article 1356 from the Michigan Agricultural Experiment Station)

Seven balance trials were conducted with three rumen-fistulated calves maintained on a purified ration in which urea furnished the only source of dietary nitrogen, and one trial was conducted with one calf maintained on a natural ration to determine the rate of disappearance of dry matter and non-protein nitrogen from the rumen and the biosynthesis of protein in the rumen. The entire rumen contents were evacuated, weighed, sampled and replaced in the rumen both before feeding and 6 hours after feeding. On the percentage basis, dry matter and non-protein nitrogen increased appreciably within 6 hours after feeding, but crude protein increased in only 4 of the 7 trials. The rate of removal of dry matter (about 60 percent) was approximately the same for the animals on the experimental and the natural rations. Of the non-protein nitrogen in the experimental ration, 90 percent of it had disappeared from the rumen within 6 hours after feeding. The data indicate an appreciable synthesis of protein in the bovine rumen from urea within 6 hours after feeding. The amount of "true" protein synthesized varied from 33 to 109 gm. The increase in protein is assumed to be due to the biosynthetic activity of rumen microorganisms.

A Quantitative Study of Rumen Synthesis in the Bovine on Natural and Purified Rations. II. Amino Acid Content of Mixed Rumen Proteins

DUNCAN, C. W., I. P. AGRAWALA, C. F. HUFFMAN, AND R. W. LUECKE

Jour. Nutri. 49: 41-49. 1953 (Journal Article 1357 from the Michigan Agricultural Experiment Station)

Mixed rumen proteins, obtained from seven trials with rumen-fistulated calves maintained on a purified ration which contained urea as the only essential source of dietary nitrogen and from one calf fed a natural ration, were assayed by microbiological methods for the amino acids known to be essential for the rat.

Quantitative evidence was obtained to show that rumen microorganisms can utilize urea-nitrogen to synthesize amino acids. With the exception of histidine, the amino acid pattern of the mixed proteins in the ingesta of the calves on the purified ration was fundamentally similar to that found for the calf on the natural ration. Minimum molecular weights calculated for the mixed rumen proteins of the calves on the purified ration were in agreement with the values obtained for the mixed rumen proteins of the calf on the natural ration.

Costs and Utilization of Labor at Four Egg Grading Stations in Michigan

LARZELERE, H. E.

Poultry Sci. 31: 1087-1092. 1952 (Journal Article 1358 from the Michigan Agricultural Experiment Station)

Time studies were made of the labor operations involved in candling and packing at four egg-grading stations under various seasonal and volume conditions. The timing observations indicated that an average of 13 minutes was required for candling a case of eggs, and on the basis of the actual wage rates paid the average cost was 18 cents per case. The average time for packing was 11 minutes per case, at an average cost of 14 cents a case. It was observed that the candlers and packers spent a considerable proportion of their time on operations other than their primary jobs. The evaluation of time on these "other operations" amounted to a cost of 23 cents a case. The combined cost of candling, packing, and performing other operations averaged 55 cents per case. In addition to the labor costs of processing eggs, other costs were encountered by the egg-grading stations, such as managerial costs in administration and merchandising, depreciation and maintenance costs of buildings and equipment used in the grading operations, and hauling costs both in procurement of eggs from farms and in the delivery of graded eggs to buyers.

General observations indicated possible arrangements of floor plans of the station to develop more efficient "flow" of the eggs through the grading and holding rooms. Further, the field reports indicated duplication of effort when eggs were candled and packed in cases and later packed into cartons.

Propagation of Malling Apple Rootstocks by Nurse-Root Grafting

O'ROURKE, F. L., AND H. B. TUKEY

Proc. Soc. Hort. Sci. 60: 101-103. 1952 (Journal Article 1362 from the Michigan Agricultural Experiment Station)

The nurse-root method of grafting was used to propagate several clones of East Malling apple rootstocks during three successive years. A short (1½ to 2 inches) seedling apple root was grafted to a long (7 to 8 inches) scion of an East Malling clone and the whole planted vertically in a field row so that the top bud of the scion was level with the surface of the ground. A copper wire twisted about the scion at the point of union aided in the production of scion roots and gradually cut off the nurse-root portion below as the diameter increased.

Survival of the East Malling grafts was influenced by soil and weather conditions. EM VII yielded the highest percent of successful plants, followed by EM II, EM I, and EM LX. Two other clones, EM IV and EM XVI gave fair results the only year tested.

At the end of the first growing season the EM I grafts were well scion-rooted, and EM VII sparsely so. EM LX had but few scion roots and EM II practically

none. At the end of the second growing season, however, all clones were well rooted. The method appears practical for the production of clonal rootstocks on a commercial basis.

Some Observations on the in Vitro Action of Neomycin

SCHOENHARD, DELBERT E., AND HENRIK J. STAFSETH

Antibiotics and Chemotherapy 3: 41-49. 1953 (Journal Article 1366 from the Michigan Agricultural Experiment Station)

The purpose of this study was to study some of the factors that may influence the antibacterial action of neomycin, using *Salmonella pullorum* as the test organism. Approximately the same concentration of neomycin killed the organisms when they were grown and tested in either 1 percent tryptose-water or nutrient broth. As for the organisms grown and tested in the synthetic medium, 80 to 160 times more neomycin was needed to kill them. The action of neomycin was favored by an alkaline medium. The antibacterial activity of neomycin was not affected significantly by lowering the temperature from 37° to 4° C. Neomycin killed almost as large a percentage of organisms when they were in the stationary phase as when they were in the logarithmic phase. The rate of action of neomycin was most rapid in the highest concentration used. The amino acids and vitamins in the concentrations tested did not influence significantly the action of neomycin; glucose, peptone, and beef extract in the concentrations tested seemed to interfere slightly with the action of neomycin; sodium chloride interfered with the action of neomycin.

Growth Curves of Salmonella Pullorum in Different Media

SCHOENHARD, DELBERT E., AND HENRIK J. STAFSETH

Jour. Bacteriology 65: 69-74. 1953 (Journal Article 1367 from the Michigan Agricultural Experiment Station)

A study was made of the bacterial culture cycle of five strains of *Salmonella pullorum,* preliminary to an investigation of the susceptibility of this organism to several antibiotics. The five strains grew best in nutrient broth and more rapidly in 1 percent tryptose broth than in a synthetic medium. None of the strains showed any evidence of a stationary phase when grown in the three media. When the organisms were grown in 1-percent tryptose water, the lag phase was of about the same duration for all strains, except for Strain 11. Two of the five strains showed no lag phase in the synthetic medium, the others had one of 6 to 12 hours. The average generation time in the logarithmic phase was longer in 1 percent tryptose water than in nutrient broth and longest in the synthetic medium. The negative acceleration phase was of about the same length for these strains in 1 percent tryptose water or in nutrient broth.

Study of Catalase in Erythrocytes and Bacteria. I. Procedure for the Determination of the Catalase Activity of Erythrocytes

RICHARDSON, MARVIS, I. FOREST HUDDLESON, AND RACHEL BETHEA

Archives Biochem. and Biophysics 42: 114-123. 1953 (Journal Article 1368 from the Michigan Agricultural Experiment Station)

A procedure is described for the determination of blood catalase activity which is satisfactory for comparing the activity of blood from one species with that of

another. The method is based on the decomposition of hydrogen peroxide under conditions which detect significant differences in the blood catalase activity and which give reproducible linear results. The blood catalase activity values obtained by the procedure described were compared with those determined by a sodium perborate method and a reaction-rate method. Experiments pertaining to the procedure adopted showed: the catalase activity of human, rabbit, and guinea pig bloods in aqueous dilutions of 1:750, 1:500, and 1:400, respectively, did not decrease during 2 hours at 0° C.; in those dilutions the activity of blood catalase from the human and guinea pig was unstable when held at 25° C. for 2 hours. Maximum catalase activity occurred in 0.1-0.2 *N* hydrogen peroxide. Dilution of hydrogen peroxide with 0.5 percent sodium chloride lowered the measurable catalase activity approximately 45 percent below the activity obtained with phosphate or tryptose diluents. Shaking the reaction mixture did not change the blood catalase values from those obtained without shaking.

Study of Catalase in Erythrocytes and Bacteria. II. Catalase Activity of Erythrocytes from Different Species of Normal Animals and from Normal Humans

RICHARDSON, MARVIS, I. FOREST HUDDLESON, RACHEL BETHEA, AND MARY TRUSTDORF

Archives Biochem. and Biophysics 42: 124-134. 1953 (Journal Article 1369 from the Michigan Agricultural Experiment Station)

Determinations were made of the catalase activity of erythrocytes from 231 human beings, 106 cattle, and 10 to 39 each of seven other mammalian species. A small number of individuals of two avian species were also included for comparative purposes. All of the individuals examined were apparently in a normal state of health.

The erythrocytes of individuals of the species examined in this study have shown the following ranges of catalase indices: human beings, 219-480; cattle, 53-148; horses, 68-114; sheep, 10-14; swine, 84-168; dogs, 3-18; rabbits, 147-271; guinea pigs, 50-299; rats, 67-82.

There was no significant change in the catalase index of erythrocytes of several human beings examined at intervals for 15 months. The catalase index of erythrocytes from cattle was shown to increase with age. A very wide range of catalase index values was found in guinea pigs and dogs. Studies made on erythrocytes from two guinea pigs, beginning 5 days after birth and extending over a 6-month period, showed that the initial high or low catalase value remained relatively constant.

Income from Timber Products in the United States

JAMES, LEE M., AND JAMES G. YOHO

Jour. For. 51: 83-87. 1953 (Journal Article 1370 from the Michigan Agricultural Experiment Station)

Income payments to individuals which are directly attributable to the production and manufacture of timber products throughout the United States are calculated at $8 billion for the year 1950. This is 4.4 percent of the nation's total income of $182 billion from all sources other than government payments. It compares with $16 billion from farming (not including manufacturing based on farm-produced raw materials), $57 billion from trades and services, $45 billion from non-timber manufacturing, and $56 billion from miscellaneous sources.

Regionally, the South ranks first in income payments from timber products; the West Coast, second. The leading northern region—the Northeast—accounts for less than a fifth of the total income from timber products; but the Northeast, Lake, and Central regions combined account for substantially more timber income than does the South. In relation to the total regional economy, timber income is most important on the West Coast, slightly less important in the South.

Income payments to individuals from timber products total at least $100 million in each of 26 states. Oregon ranks first among the states, followed by Washington, California, New York, and Michigan.

Capillary Rise of Water in Soils Under Field Conditions

BOUYOUCOS, GEORGE JOHN

Jour. Phys. Chem. 57: 45-49. 1953 (Journal Article 1371 from the Michigan Agricultural Experiment Station)

A new electrical resistance method was developed which makes possible a continuous measurement of the soil moisture content of soils under field conditions. This method was applied to the study of the capillary rise of water in soils under controlled field conditions. It proved to be very successful and practical. The results obtained show that where excessive rainfall did not cause the water tables to rise to wet the soil by close proximity, there was practically no capillary rise from the water tables to the upper soil horizons which had a high moisture gradient and tension gradient. There was also very little movement of water from the wetter to the drier soil layers above. It is concluded that capillary movement of water from the water table supplies little, if any, water to the plants during a season of growth. The roots of plants, accordingly, have to go to the water, which they accomplish with greater ease and rapidity than capillarity can bring it to them. Capillarity is important in supplying plants with water only through very short distances.

Comparative Effects of Low Temperature Exposure, Limited Soil Moisture and Certain Chemical Growth Regulators as Hardening Agents for Greenhouse Grown Tomatoes

LEARNER, E. N., AND S. H. WITTWER

Proc. Am. Soc. Hort. Sci. 60: 315-320. 1952 (Journal Article 1381 from the Michigan Agricultural Experiment Station)

The authors made a comparative study of the effects of various hardening practices and agents, including temperature and moisture reductions and treatment with certain growth-regulating chemicals on greenhouse-grown tomatoes. With plants hardened with 2.5 mg. of 4-phthalimido-2, 6-dimethyl pyrimidine the total weight of fruit harvested during the first 2 weeks was increased 12 percent. A soil application of 2.5 mg. of maleic hydrazide induced a 45 percent greater accumulation of total sugars in the roots and a drastic reduction of the fruit yield. Alpha-ortho-chlorophenoxy propionic acid at 2.5 mg. per plant, when applied to the soil, resulted in a 67-percent decrease in percentage of total sugar in the roots, followed by a 12-percent reduction in total number of fruit harvested. The 40° F. temperature treatment, regardless of moisture level, reduced the total water loss 77 to 85 percent, but significantly reduced both early and total yields. As a hardening treatment, limiting the water supply was significantly more effective in increasing the sugar content of both tops and roots than was a 10-day temperature exposure to 40° F.

Unidentified Dietary Factors in Dairy Cattle Nutrition. III. The Nutritive Value of Immature Alfalfa and Timothy Hays for Milk Production

HUFFMAN, C. F., S. T. DEXTER, AND C. W. DUNCAN

Jour. Dairy Sci. 35: 1001-1009. 1952 (Journal Article 1383 from the Michigan Agricultural Experiment Station)

Seventeen milking cows were used in 25 trials to determine the effect on milk production when all or part of a mature hay was replaced with an immature hay. In general, the immature hays stimulated milk production when they replaced part or all of the total digestible nutrients (T.D.N.) in mature hay. Equally satisfactory or better results, however, can be obtained on the same T.D.N. intake when less hay is fed, provided the ration is balanced with corn. Thus no agronomic or economic implications concerning the use of early-cut forages are intended or implied. The apparent exceptional value, from the standpoint of coefficients of digestibility and T.D.N. of the timothy hay cut in the preboot stage was not evident when it was fed as a supplement to a mature hay. When corn replaced immature hay on an equal T.D.N. basis, there was a marked increase in milk production. The results provide further evidence that the amount of unidentified lactation factor(s) in hay cannot be estimated by either the T.D.N. starch equivalent or by a calculated net-energy system of feed evaluation.

Comparison of Certain Standard and Experimental Fungicides in Potato Late Blight Control

MUNCIE, J. H.

Am. Potato Jour. 29: 186-191. 1952 (Journal Article 1386 from the Michigan Agricultural Experiment Station)

Total yield increases from application of materials No. 1189, F-1003, Parzate, Orthocide 406, manganese ethylene bisdithiocarbamate, Fungicide C and Cop-O-Zinc were statistically significant over check plots sprayed only with DDT.

Significant increases in yield of U. S. No. 1 grade were obtained by application of all fungicides except materials No. F-1109 and No. 1217 at 5 pounds per 100 gallons.

Low incidence of foliage infection was noted in plots sprayed with materials F-1109, manganese ethylene bisdithiocarbamate, Cop-O-Zinc, No. 1124 and No. 1217 at 6¾ pounds per 100 gallons.

Tuber rot was slight in plots sprayed with material No. 1189, Orthocide 406, manganese ethylene bisdithiocarbamate, bordeaux mixture, F-1003 and No. 1124.

Protein-Bound Iodine Levels in Dairy Cattle Plasma

LEWIS, R. C., AND N. P. RALSTON

Jour. Dairy Sci. 36: 33-38. 1953 (Journal Article 1389 from the Michigan Agricultural Experiment Station)

The plasma protein-bound iodine (PBI) concentration of dairy animals of different ages and breeds was determined. The PBI level tended to decrease with age. No significant difference in PBI levels of Jersey and Holstein cows could be detected. A herd of Jersey cows brought from California and a group of sterile cows had similar plasma PBI levels which were significantly lower than the concentrations found in the main College Herd.

Beneficial Effects of Vitamin B_{12} and Aureomycin in Rats Given Large Doses of Cortisone

MEITES, JOSEPH

Proc. Soc. Exp. Biol. and Med. 81: 307-311. 1952 (Journal Article 1404 from the Michigan Agricultural Experiment Station)

Fifty young male albino rats were uniformly divided into five equal groups and placed on a purified casein-glucose diet. After a preliminary period of 2 weeks, all except a control group were injected for 28 days with 1 mg. of cortisone acetate daily with or without vitamin B_{12} and or aureomycin.

Cortisone acetate alone induced complete inhibition of body growth, severe alopecia and marked atrophy of the thymus gland. Vitamin B_{12} (200 μg/kilogram diet) or aureomycin (0.005 percent) largely counteracted these inhibitory effects of cortisone acetate, and the combination of the two was more effective than was either alone. It was concluded that large doses of cortisone acetate given to young rats on a casein-glucose diet increased their requirements for vitamin B_{12} and other factors. These data corroborate results previously obtained in a similar experiment on rats fed a corn-soybean meal diet.

Supplementation of a Corn-Meat and Bone Scrap Ration for Weanling Pigs

BLOSS, R. E., R. W. LUECKE, J. A. HOEFER, F. THORP, JR., AND W. N. MCMILLEN

Jour. An. Sci. 12: 102-106. 1953 (Journal Article 1409 from the Michigan Agricultural Experiment Station)

A corn-meat and bone scrap ration, supplemented with minerals and vitamins, was found to be inadequate for the growth of pigs fed in drylot. The addition of 0.06 percent of DL-tryptophan to this ration allowed growth to proceed at the same rate as that observed in animals on a corn-soybean oil meal diet. When half of the meat and bone scrap protein was replaced with soybean oil meal protein, the growth equalled that obtained in the corn-soybean oil meal lot. Aureomycin was not effective in counteracting the tryptophan deficiency of the basal ration.

Antibiotics in Rumen Digestion and Synthesis. I. The Effect of Aureomycin on Rumen Digestion and the Passage of Nutrients from the Rumen During Specific Intervals After Feeding

CHANCE, C. M., C. F. HUFFMAN, AND C. W. DUNCAN

Jour. Dairy Sci. 36: 253-259. 1953 (Journal Article 1411 from the Michigan Agricultural Experiment Station)

Two rumen-fistulated steers were used in a study to ascertain the influence of aureomycin on rumen digestion and the rate of passage of certain nutrients from the rumen. Aureomycin was fed at the rate of 0.5 gm. daily for 15 days and then 1.0 gm. daily for the next 15 days. The period in which the steers received no aureomycin served as the control period. Neither of the steers showed signs of anorexia or diarrhea at any time during aureomycin supplementation. The rumen contents were completely evacuated, weighed, sampled and replaced in the rumen before feeding (0-hour) and again at 6 and 12 hours after feeding. The rate of removal of dry matter, crude fiber, crude protein and nitrogen-free extract was the highest when 0.5 gm. of aureomycin was fed. There was an

accumulation of dry matter, crude protein, and nitrogen-free extract in the rumen at the 0-hour period when 1.0 gm. of aureomycin was included in the ration. This suggests that a slight depression in the digestibility of these constituents may have occurred. There was a definite accumulation of ether extract in the rumen at the 0-hour period when both levels of aureomycin were included in the ration.

Scrapie in Sheep

THORP, FRANK, JR., A. W. JUDD, M. L. GRAY, AND L. B. SHOLL

MSC Vet. 13: 36-37. 1952 (Journal Article 1431 from the Michigan Agricultural Experiment Station)

Scrapie was diagnosed in a flock of sheep (Michigan) in 1947. During a period of 7 years from 1939 to 1946, 17 imported sheep (Canada or England), had been added to the flock. The diagnosis of scrapie was based on clinical symptoms, degeneration of Purkinje cells and vacuolization of neurons in the medulla.

The Folic Acid Content of Fresh and Stored Shell Eggs

EVANS, ROBERT JOHN, J. A. DAVIDSON, DORIS BAUER, AND HELEN A. BUTTS

Jour. Agr. Food Chem. 1: 170-172. 1953 (Journal Article 1438 from the Michigan Agricultural Experiment Station)

Eggs from 10 White Leghorn hens kept in laying cages and fed a diet of constant composition were used in an experiment to study changes in the folic acid content of fresh and stored shell eggs. Whites and yolks of fresh eggs and of eggs stored for 3, 6, or 12 months at 0° C. were assayed for folic acid with *S. faecalis R.* Fresh eggs contained, on the average, 4.59 μg. (94 mμg. per gram) of folic acid, with 0.51 μg. (16 mμg. per gram) being in the white and 4.09 μg. (232 mμg. per gram) in the yolk. There was a loss of folic acid from the egg yolk and some transfer of folic acid from the yolk to the white during 12 months of cold storage. Twelve-month-old eggs contained 3.37 μg. (74 mμg. per gram) of folic acid, with 0.62 μg. (24 mμg. per gram) being in the white and 2.75 μg. (142 mμg. per gram) in the yolk.

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